BOONTON ELECTRONICS CORPORATION

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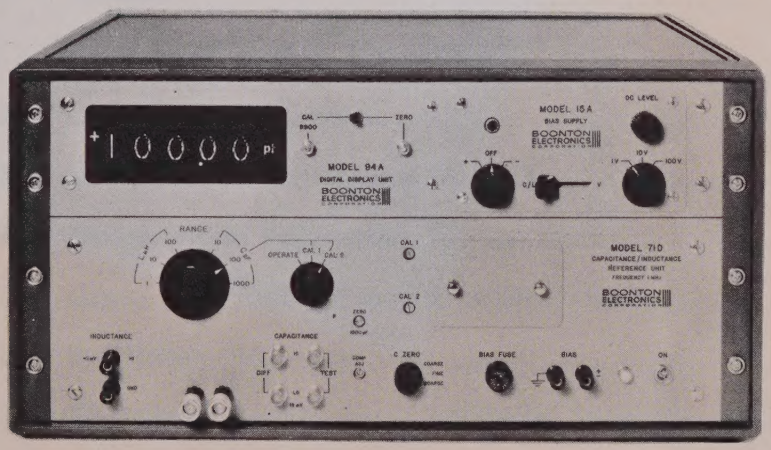
OPERATOR'S MANUAL

for

DIGITAL C/L METER MODEL 700A



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CHAPTER 1

DESCRIPTION AND DATA

1-1 PURPOSE AND DESCRIPTION

Digital C/L Meter Model 700A is a self-contained, digital type test equipment used to perform precise measurements of three-terminal capacitance specimens and two-terminal inductance specimens at 1 MHz. The 700A also provides and measures a dc bias voltage that is variable ± 100 V. All measured values are illuminated and displayed on a digital type indicator. Test specimens may be connected to the 700A by means of coaxial cables and a test jig, or they may be connected directly to the front panel terminals. A pair of BNC-to-binding-post adapters are stored on the front panel to facilitate direct connections to the 700A. An internal 100 pF capacitance standard is used to calibrate the 700A, and a toggle switch on the rear panel offers an option for external triggering. An electrical binary coded decimal (BCD) output, available at a rear panel connector, permits the 700A to be used in system applications for driving printers, tape or card punches, data control units, and similar interfacing data equipment.

1-2 MODEL 700A CONFIGURATION

Digital C/L Meter Model 700A consists of Capacitance/Inductance Reference Unit 71D, Digital Display Unit Model 94A, and Bias Supply Model 15A. The 71D unit provides the measuring functions, supplies the 1 MHz test signal, and contains the 100 pF capacitance standard. The 94A unit computes the measurement and displays it as a plus or minus numeric readout along with the applicable measurement mode symbol. The 94A provides an accurate readout up to 140% of full-scale for each measurement range. However, a fifth digit is displayed from 100% to 140% of full-scale. If the 40% overrange tolerance is exceeded, the digital display will blank out and an OVERRANGE warning will be displayed until the RANGE switch is advanced to a higher measurement range. The 15A unit is used to apply a variable ± 100 V internal bias voltage between the 71D CAPACITANCE HI and LO terminals (and across any specimen connected either to the TEST or the DIFF terminals). If a bias voltage greater than 100 V is required, the 15A internal supply can be bypassed and an external dc source, up to ±200 volts, may be connected to the 71D BIAS terminals. The 700A measures and indicates only up to ±100 V dc, and neither the internal nor external bias appears across the INDUCTANCE terminals.

1-3 MEASUREMENT CONSIDERATIONS

The 700A ignores stray capacitance from the LO post to ground and measures the capacitance value of the test specimen only. The stray capacitance from the HI post to ground has no significant influence above 10 pF, and the effects of stray capacitance below 7 pF can be negated by the 71D COMP ADJ control. The COMP ADJ control also is used to negate the capacitance introduced by coaxial cables during remote measurement, and the direct capacitance introduced by a test jig can be balanced out by the 71D C ZERO control. Thus, specimens can be connected either locally or remotely to the 700A without incurring errors caused by capacitance from either side of the test to ground. However, when coaxial cables are used to connect specimens to the 700A, the effects of series inductance introduced by the cables must be taken into consideration because erroneous readings can result. The correction for series inductance errors is a simple procedure and is discussed in paragraphs 3-9 and 3-11.

1-4 TECHNICAL CHARACTERISTICS

Capacitance Measurements (3-terminal):

Range.....0 to 1000 pF

Accurance.....0.25% of reading + (0.1% + $\frac{3}{Q}$%)fs + 0.002 pF

Where Q=Q of test specimen

Resolution.....4 digits

Inductance Measurements (2-terminal):

Range.....0 to 100 μH

Accuracy.....0.5% of reading + (0.5% + $\frac{6}{Q}$ + $\frac{L\mu H}{500}$%) fs + 0.0005 μH

Where

LμH = test specimen inductance

Q = Q of test specimen

Resolution.....4 digits

Test Signal:

Frequency.....1 MHz, crystal controlled, ±0.01%

Level:

Capacitance measurements.....15 mV, rms, ± 1 mV

Inductance measurements..... <1 mV, rms

15A Bias Supply:

Internal bias.....0 to ± 100 V, -0% + 5% full scale, continuously variable, fused, & digitally monitored

External bias..... Up to ± 200 V at 250 mA may be applied at fused BIAS terminals; 0 to ± 100 V digitally monitored.

Voltage monitoring accuracy..... ± 0.5% fs (± 2 digits)

Regulation
(Unregulated, zener-stabilized bias supply; applies bias voltages at very low currents.)

± 1 V range	1 μA for approximately 1% voltage drop.
± 10V range	10 μA for approximately 1% voltage drop.
± 100V range	1 mA for approximately 1% voltage drop.
Drift (After 15 minute warm-up)	
0 to 2 hours	± 2%
2 to 8 hours	± 0.25%
BCD Output	4-line (8,4,2,1), where logic 1 ≥4V and logic 0 ≤ 0.4V
Temperature-coefficient	0.15%/C°
Power Requirements	117 V or 234 V, ± 10%; 50 to 60 Hz
Power Consumption	110 watts
Dimensions	19-1/2" wide, 9-7/8" high, 17-7/8" deep
Weight	47 lb

CHAPTER 2

INSTALLATION

2-1 UNPACKING AND INSPECTION

Remove the packing material from the shipping carton and carefully remove the 700A. If feasible, the carton and packing material may be stored for possible future reshipment. Carefully inspect the 700A for any damage that may have resulted during shipment. If there is any damage or defect, contact either your local sales engineering representative or the Boonton Electronics Corporation (see title page for factory address).

2-2 PACKAGING FOR RESHIPMENT

If required, pack the 700A for reshipment to the manufacturer in accordance with the shipping instructions on the warranty. Observe the following special packing instructions.

a. If possible, use the original shipping carton and packing material.

b. Coil the power cable inside the rear panel compartment.

c. Tie a tag or envelope to a BIAS binding post and include the following information:

   1. Name and address of purchaser.

   2. Model number and serial number of equipment.

   3. Full description of damage or defect.

2-3 POWER CONNECTIONS

Check that the ac power source is 117 volts (±10%), 50 to 60 Hz, and connect the power cable plug to an appropriate receptacle. If a 3-terminal ac receptacle is available, remove the 3- to 2-terminal ac plug adapter from the power cable before making the power connection. If a 2-terminal ac receptacle is to be used, connect the plug adapter pigtail to ground when the adapter is connected to the receptacle. Either procedure puts both the front panel and the cabinet at ground potential and protects operating personnel from electrical shock hazards.

CHAPTER 3

OPERATION

3-1 GENERAL

This chapter contains operating instructions for the 700A and includes procedures for capacitance (C) and inductance (L) measurements, bias application, C differential measurements, correcting for external cable inductance, and calibrating the 700A. Before attempting any measurements, observe the preliminary operating instructions in Section 1, below.

Section 1. PRELIMINARY OPERATING INSTRUCTIONS

3-2 CONTROLS AND INDICATORS

The controls and indicators of the 700A are illustrated in Figure 3-1 and are functionally described in Table 3-1. Thoroughly review the function of each item in the table before performing any adjustments or measurements on the 700A.

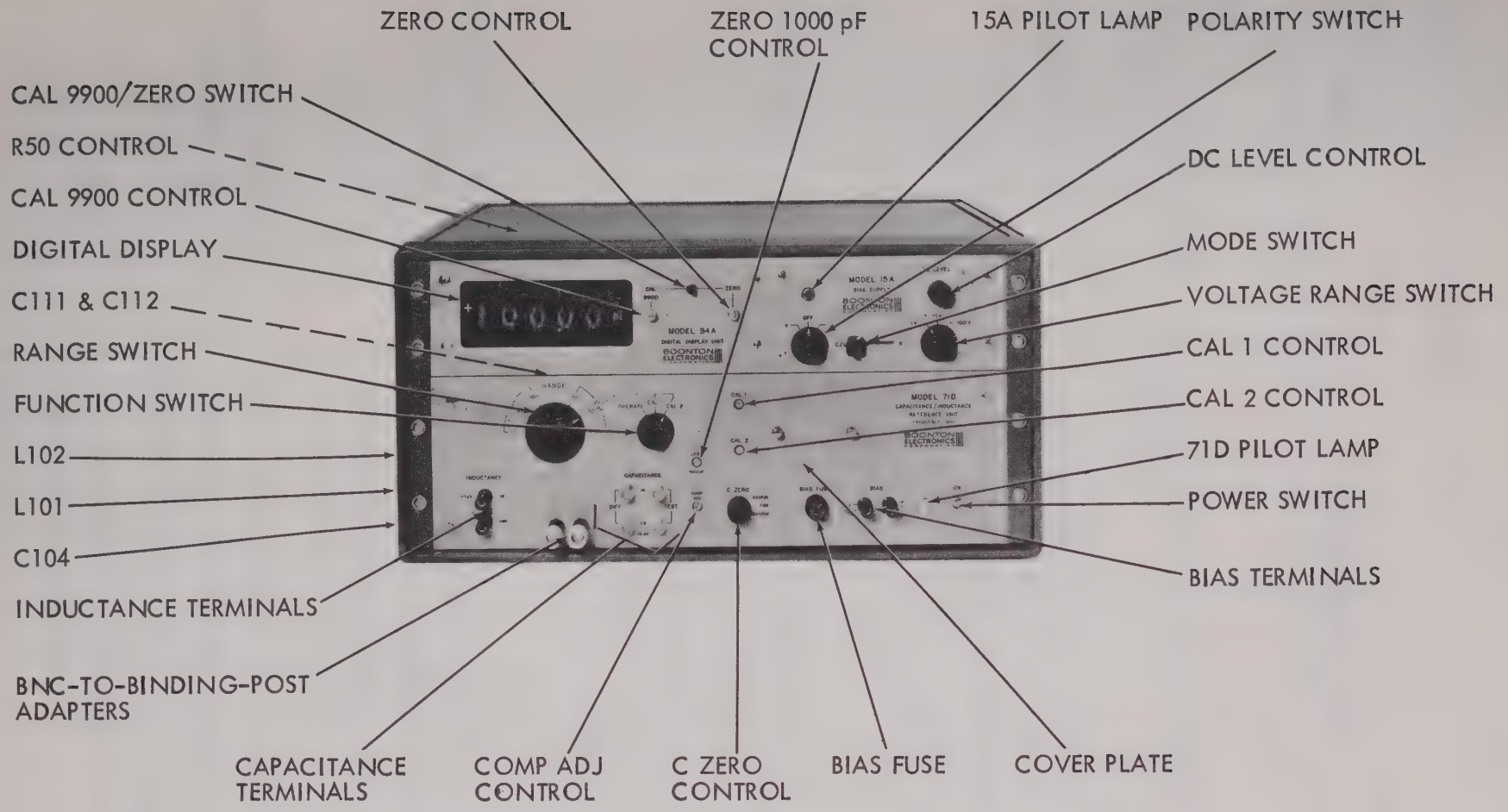


Figure 3-1. Model 700A Controls and Indicators.

Table 3-1. Controls and Indicators

Item	Description and Function
71D Unit:	
INDUCTANCE HI and GND terminals	Binding posts used to connect inductors to the 700A.
RANGE switch	7-position rotary switch used to select measurement mode and range. LμH 1, 10, and 100 positions used for inductance measurements, and CpF 10, 100, and 1000 positions used for capacitance measurements. Top-center position not used.
Function switch	3-position rotary switch designated as OPERATE, CAL 1, and CAL 2. The OPERATE position is used when measuring capacitance, inductance, or bias voltage. The CAL 1 and CAL 2 positions respectively provide a high Q and low Q internal 100 pF capacitance standard for calibration.
CAPACITANCE TEST HI and LO terminals	BNC connectors used to connect capacitance specimens to the 700A. Specimens may be connected directly (using BNC-to-binding-post adapters discussed below) or remotely by means of coaxial cables and a test jig.
CAPACITANCE DIFF HI and LO terminals	BNC connectors used to connect capacitance specimens to the 700A, as discussed above. A capacitance connected to the CAPACITANCE TEST terminals produces a positive reading, while the same capacitance connected to the CAPACITANCE DIFF terminals causes a comparative negative reading. The CAPACITANCE DIFF terminals are used to make differential

Table 3-1. Controls and Indicators (cont)

Item	Description and Function
	capacitance measurements, and to extend the range of the C ZERO control.
BNC-to-binding-post adapters	Adapters stored on the 71D front panel directly below the RANGE switch. Used to connect test specimens directly to the CAPACITANCE TEST or DIFF terminals.
C ZERO control	Continuously variable control used to balance out capacitance introduced across the CAPACITANCE terminals by connecting leads or a test jig. The C ZERO control can neutralize up to approximately 7 pF of cable or jig capacitance, but its range may be increased by connecting an external capacitance to the CAPACITANCE DIFF terminals (para. 3-12). For about 270 degrees of rotation, the C ZERO control turns easily, and then the torque requirement increases sharply as the control shifts from a 36:1 FINE ratio to a 6:1 COARSE ratio.
ZERO 1000 pF control	Screwdriver-adjust control used to zero the 1000 pF position of the RANGE switch. Proper alignment of the 1000 pF RANGE switch circuit is essential for accurate measurements of both capacitance and inductance. The 1000 pF position on the RANGE switch should be checked periodically. The ZERO 1000 pF control has the same vernier drive described for the C ZERO control, above, but it is not continuously variable.

Table 3-1. Controls and Indicators (cont)

Item	Description and Function
COMP ADJ control	Screwdriver-adjust control used to negate stray capacitance between the inner conductors of the CAPACITANCE TEST and DIFF HI BNC connectors and the outer conductors. The COMP ADJ control can tune out approximately 100 pF. Normally, stray capacitance is balanced out on the 10 pF range only, because the amount of stray capacitance required to cause a 1% error is more than two times the full-scale of the range used. When measuring on the 10 pF range, adjust the COMP ADJ control under the following circumstances: a. When the 700A is first operated. b. When the specimen connection system is changed (e.g., from cables or test jig to direct connection). c. When measuring a capacitance standard. d. When a specimen has a markedly different HI-post-to-ground capacitance (caused by different internal construction, encasing, or terminations) than specimens measured previously.
BIAS terminals	Binding posts used to connect external bias voltages, up to ± 200 volts at 250 mA, to the 700A. The applied bias voltage appears across the CAPACITANCE TEST and DIFF terminals but not across the INDUCTANCE terminals. The digital display will readout external bias up to 140V (100V + 40% overrange) if mode switch is at V, voltage range switch is at appropriate 1V, 10V, or 100V setting, and polarity switch is at OFF (EXT BIAS).

Table 3-1. Controls and Indicators (cont)

Item	Description and Function
BIAS fuse	250 mA fuse both in the internal and external-bias input circuits. Protects internal circuits from short circuit or overload damage.
CAL 1 control	Screwdriver-adjust control used in conjunction with the function switch CAL 1 position to calibrate the 700A at 100 pF for high Q (>10) measurements.
CAL 2 control	Screwdriver-adjust control used in conjunction with the function switch CAL 2 position to calibrate the 700A at 100 pF for low Q (Q=3) measurements.
Power switch	Toggle switch used to control ac power for the 700A.
Pilot lamp	Glows when the 700A is energized.
C10, C100, C1000, L1, L10, L100 controls	Screwdriver-adjust controls accessible when front panel cover plate (directly above the BIAS FUSE) is removed. Each control is labeled in correspondence with a RANGE switch position, and the control is used to calibrate the designated switch position. These controls are preset at the factory and should not be touched.
L101 control	Screwdriver-adjust control accessible through hole in left side of cabinet. Used to zero the 700A in the 1 μH position of the RANGE switch.

Table 3-1. Controls and Indicators (cont)

Item	Description and Function
L102 control	Screwdriver-adjust control accessible through hole in left side of cabinet. Used to compensate for inductance of internal wiring. This control has been preset at the factory and should not be touched.
C104 control	Screwdriver-adjust control accessible through hole in left side of cabinet. Used to calibrate the 100 μH position of the RANGE switch. This control has been preset at the factory and should not be touched.
C111 and C112 controls	Screwdriver-adjust controls accessible through holes on top of 71D chassis cover. Used to adjust the 100 pF capacitance standard. These controls have been preset at the factory and should not be touched.
71D Rear Panel:	
COARSE CAL 2 control	Screwdriver-adjust control, functions as a coarse adjustment for front-panel CAL 2 control.
R415 control	Screwdriver-adjust control used to adjust operating point of internal circuits. This control is preset at the factory and should not be touched.
FUSE	0.5 amp fuse in primary circuit of power transformer protects 700A circuits from short circuit and overload damage.

Table 3-1. Controls and Indicators (cont)

Item	Description and Function
94 Unit:	
Digital display	Nixie-tube indicators provide + or - numerical readout with the appropriate measurement mode symbol. Four digits are displayed from .0000 to 99.99% of full scale for each RANGE switch setting, and a fifth digit is displayed above 99.99% of full scale. An OVERRANGE warning is activated when the readout reaches 40% above full scale. If the 40% tolerance is exceeded, the readout will remain constant, and the digital display eventually will blank out.
CAL 9900/ZERO switch and controls	Three-position toggle switch, spring-returned to center (off) position. CAL 9900 position connects CAL 9900 screwdriver-adjust control which is used to calibrate the digital display indicator at 9900. ZERO position connects ZERO screwdriver-adjust control which is used to calibrate the digital display indicator at 0000.
R50 control	Trimpot control accessible through hole on top of cabinet over digital display. Functions as coarse adjustment for CAL 9900 control. CAUTION: R50 is mounted on a 94A printed circuit board. Do not exert any pressure when adjusting R50.

Table 3-1. Controls and Indicators (cont)

Item	Description and Function
94A Rear Panel:	
TRIGGER switch	Double-throw toggle switch. INT position used for internal triggering; EXT position disables internal trigger and permits external triggering.
15A Front Panel:	
Polarity switch	Three-position rotary switch. + position applies positive bias, - position applies negative bias, and OFF (EXT BIAS) position disables the internal bias supply.
Pilot Lamp	Glows when the polarity switch is either in the + or the - position.
Mode switch	Two-position slide switch. C/L position applies bias voltage across the CAPACITANCE TEST and DIFF terminals on the 71D. (Polarity of voltage is controlled by polarity switch, described above.) V position permits the bias voltage to be metered and displayed on the digital indicator.
Voltage range switch	Three-position rotary switch used to establish maximum output of bias voltage level at either 1V, 10V, or 100V. Also sets the range for the digital display when measuring either internal or external bias.
DC LEVEL control	Used to vary the level of the bias supply output within the limit established by the voltage range switch position. Fully clockwise position produces maximum bias level.

3-3 INITIAL CONTROL SETTINGS AND WARM-UP

Set the 700A controls (Fig. 3-1) in accordance with Table 3-2, below, and allow at least two hours for warm-up from normal room temperature before proceeding to the preoperational adjustments in paragraph 3-4.

Table 3-2. Initial Control Settings

Item	Setting or condition
71D Front Panel:	
RANGE switch	10 pF
Function switch	OPERATE
Power switch	ON (71D pilot lamp glows)
INDUCTANCE, CAPACITANCE, and BIAS terminals	Free of any specimen or connection
15A Front Panel:	
Polarity switch	OFF (15A pilot lamp is extinguished)
Mode switch	C/L
Voltage range switch	Any position
DC LEVEL control	Fully counterclockwise
15A Rear Panel:	
TRIGGER switch	INT

3-4 PREOPERATIONAL ADJUSTMENTS

Before making the following adjustments, check that the 700A has warmed up for at least two hours and that the settings and conditions of Table 3-2 have been observed.

a. Hold the CAL 9900/ZERO toggle switch on the 94A in the ZERO position and adjust the ZERO control until the digital display reads 0000, ± 0003. Release the toggle switch.

b. Hold the 94A CAL 9900/ZERO toggle switch in the CAL 9900 position and adjust the CAL 9900 control until the digital display reads 9900, ± 0003. Release the toggle switch.

c. If the BNC-to-binding-post adapters and/or a test jig will be used to connect capacitance specimens (para.3-8) connect the adapters, jig, or connecting cables, as required, to the CAPACITANCE TEST HI and LO terminals on the 71D.

d. Adjust the C ZERO control on the 71D until the digital display reads approximately 7.500 pF.

e. Peak the COMP ADJ control for a maximum reading on the digital display. If the digital display should indicate OVERRANGE, readjust the C ZERO control until the display is on range, and repeak the COMP ADJ control.

f. Adjust the C ZERO control for a readout of 0.000, ± 0.003, pF. If the BNC-to-binding-post adapters are installed on the CAPACITANCE TEST terminals, minimize operator proximity to the adapters. Hand- or body-capacitance effects may cause variations in readings during the C ZERO adjustment.

g. Set the RANGE switch to 1000 pF and adjust the ZERO 1000 pF control for a readout of 000.0, ± 0.3, pF.

h. Setthe RANGE switch to 10 pF and check that the digital readout is 0.000, ± 0.003, pF. If the readout is not within tolerance, repeat steps d through h.

NOTE:

The proper adjustment of the ZERO 1000 pF control is essential for accurate C and L measurements. During operation, check the 1000 pF Range position occasionally for a readout of 000.0, ±0.3, pF. If the readout is not within tolerance, perform steps d through h, above.

i. Perform the calibration procedures in paragraphs 3-5 and 3-6, below.

3-5 CAPACITANCE CALIBRATION WITH INTERNAL STANDARD

A 100 pF internal capacitance standard provides facilities for calibrating capacitance-measuring circuits in the 700A. The capacitance standard is a three-terminal, 1 MHz transfer standard traceable to the U. S. National Bureau of Standards, and it provides calibration options for both high-Q (Q>10) and low-Q (Q=3) measurements. Proceed as follows:

a. Set the 71D RANGE switch to 100 pF.

b. Set the function switch to CAL 1 (high Q).

c. The digital readout should be 100.00, ±0.03, pF. If the readout is not within tolerance, adjust the CAL 1 control.

d. Set the function switch to CAL 2 (low Q).

e. The digital readout should be 100.00, ±0.03, pF. If the readout is not within tolerance, adjust the CAL 2 control. If the CAL 2 control is out of range, set it at middle range and adjust the COARSE CAL 2 control on the rear panel of the 71D until proper ranging is restored.

f. Turn the function switch back to CAL 1 and check that the readout still is 100.00, ±0.03, pF. If the readout is not within tolerance, repeat steps c through f.

g. If the CAL 1 or CAL 2 control was adjusted in steps c or e, above, repeat paragraph 3-4f, through h and then repeat steps a through f, above, until all readings are within tolerance.

3-6 INDUCTANCE CALIBRATION

a. Connect a short length of No. 22 AWG copper wire between the INDUCTANCE HI and GND terminals on the 71D. The wire should be taut between the two terminals.

b. Set the RANGE switch to 1μH and check for a readout of .0090, ±0.0003, μH. If the readout is not within tolerance, adjust L101 for a correct readout. SEE FIG 3-1 PAGE 3-2

c. Remove the wire from the INDUCTANCE terminals and set the RANGE switch to 10 pF.

d. Set the function switch to OPERATE.

3-7 CAPACITANCE CALIBRATION WITH EXTERNAL STANDARDS

If required, capacitance-measuring circuits in the 700A may be calibrated at check points other than 100 pF by using high-Q, 1 MHz, three-terminal capacitance standards, such as the Boonton Electronics Model CS-series. The use of low-Q capacitance standards is not recommended; the procedure in paragraph 3-5 provides adequate calibration for low-Q measurements.

a. Connect the high-Q, 1MHz capacitance standard to the 71D CAPACITANCE TEST HI and LO terminals. The connecting cables should be as short as possible and not more than 3 to 4 inches for capacitance values>100 pF.

b. Set the RANGE switch to a CpF position consistent with the value of the capacitance standard.

c. Peak the COMP ADJ control for a maximum readout on the digital display.

d. Disconnect the CAPACITANCE TEST LO cable from the capacitance standard.

e. Adjust the C ZERO control until the digital display reads 0.000, ±3 on the last digit.

f. Connect the CAPACITANCE TEST LO cable to the capacitance standard and read the value on the digital display.

g. The readout should agree with the value and tolerance of the capacitance standard.

h. If necessary, adjust the CAL 1 control until the readout and the capacitance standard values are in agreement. However, if the CAL 1 control is adjusted,

repeat paragraph 3-4f through h and steps a through g, above, until all readings are within tolerance.

i. Remove the external capacitance standard.

Section 11. CAPACITANCE MEASUREMENTS

3-8 GENERAL

Be sure that the preoperational adjustments are completed before attempting any measurements described in this section. Capacitance specimens can be measured either locally or remotely. The measurement is local when the specimen is connected directly at the CAPACITANCE TEST HI and LO terminals by means of the BNC-to-binding-post adapters or a test jig connected directly to the adapters. Perform local measurements in accordance with the procedure in paragraph 3-10. The measurement is remote when the test jig is cable-connected to the 700A. For remote measurements, observe the instructions in paragraph 3-9 before performing measurements (para.3-10), and correct for cable inductance in accordance with paragraph 3-11. When performing capacitance measurements, also observe the applicable instructions in paragraphs 3-12 through 3-14.

3-9 REMOTE MEASUREMENT CONSIDERATIONS

Use RG-62/U or similar low-capacitance coaxial cables to connect the remote test jig to the 700A. The length of the cable pair should not exceed five feet for measurements on the 10 pF range, and shorter lengths should be used on the higher capacitance ranges. Refer to Figure 3-2 for cable inductance correction infomation that may be used as a guide in selecting practical cable lengths. If capacitance specimens are to be measured on the 10 pF range, perform the procedure below before making any measurements.

a. Check that the test jig is connected to the CAPACITANCE TEST HI and LO terminals and the RANGE switch is at 10 pF.
b. Connect a typical test specimen to the test jig terminals.
c. Peak the COMP ADJ control for a maximum readout on the digital display.
d. Remove the test specimen from the test jig.
e. If necessary, adjust the C ZERO control for a readout of 0.000, ±0.003,pF.

3-10 MEASURING CAPACITANCE SPECIMENS

a. Set the 71D RANGE switch to a C pF position consistent with the test specimen value.

b. Connect the test specimen to the CAPACITANCE TEST HI and LO terminals or to the terminals of any connecting adapters or test jig.

c. Read the value of the test specimen on the digital display.

3-11 CORRECTING FOR CABLE INDUCTANCE

When a test specimen is remotely connected to the 700A, the series inductance of the connecting cables and the inductance of the specimen can cause measurement error. The measured value (C_m) of the test specimen will read higher than the true capacitance (C_t) in accordance with the following expression:

$$C_m = \frac{C_t}{1-\omega^2 L C_t} = \frac{C_t}{1-(X_L/X_{C_t})} \quad \text{or} \quad C_t = \frac{C_m}{1+(X_L/X_{C_t})}$$

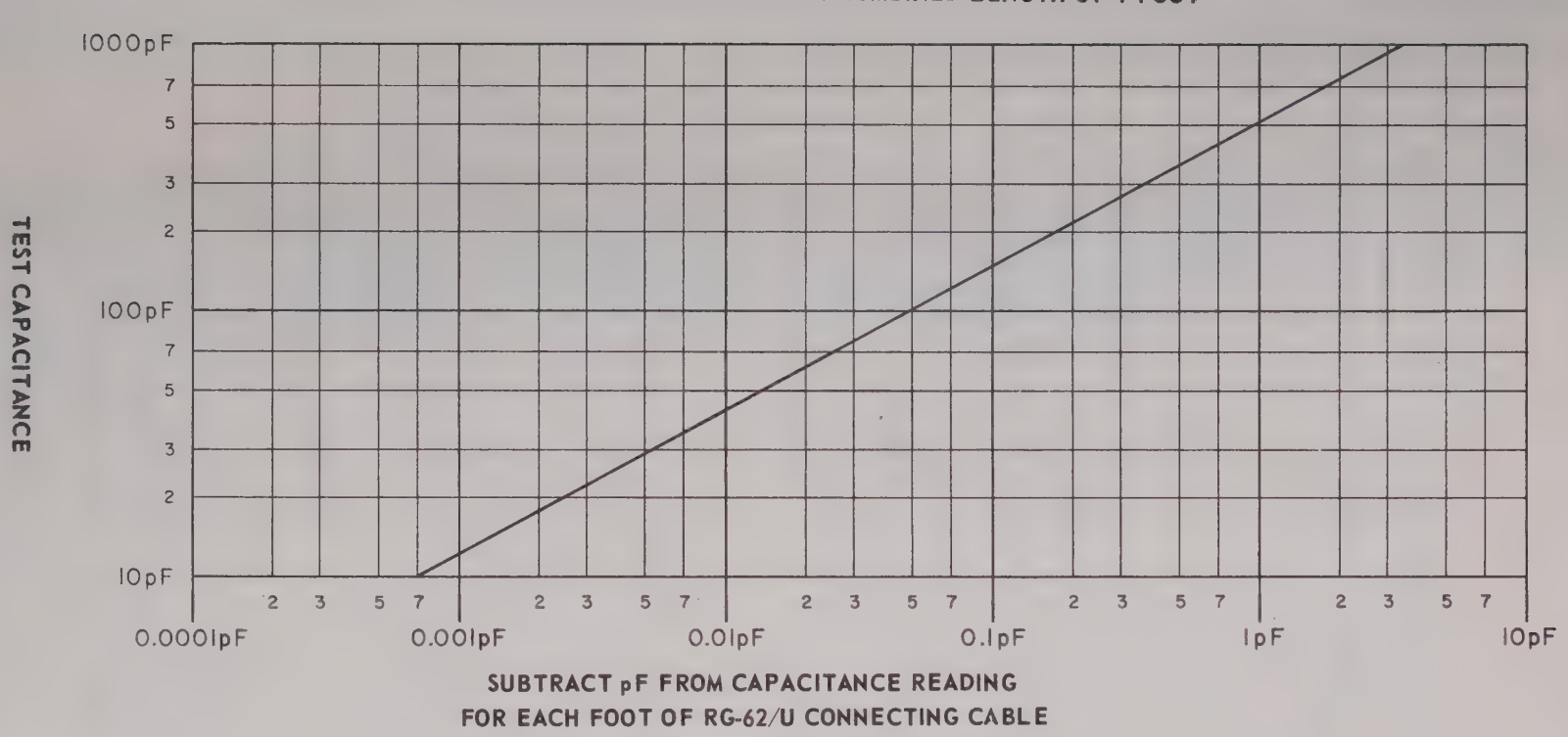
Where,

L = the combined series inductance in μH of both lengths of connecting cables and the inductance of the test specimen (generally small compared to cable inductance).

Figure 3-2 indicates the correction to be made per each foot of an RG-62/U pair for measured values ranging from 10 pF to 1000 pF.

3-12 EXTENDING THE C ZERO RANGE

The C ZERO control can balance-out up to 7 pF between either the CAPACITANCE TEST HI and LO terminals or the CAPACITANCE DIFF HI and LO terminals. Occasionally, an external jig assembly may contribute more than 7 pF capacitance and render the C ZERO control ineffective. When required, the range of the C ZERO control can be extended up to approximately 30 pF by connecting a high-quality mica capacitor to the CAPACITANCE DIFF HI and LO terminals. Ideally, the value of the mica capacitor should approximate the estimated capacitance contributed by the external fixture.



NOTES

1. Since the effect of series inductance is to cause an apparent increase in capacitance, the correction is subtracted from the measured value.

2. Correction values shown in this table are for a pair of RG-62/U cables having a combined length of 1 foot. (correction for RG-58/U are not substantially different.) The two cables need not be of the same length.

3. Since the correction is very nearly a direct function of cable length for small corrections (10% or less), the correction for cable pairs of other lengths may be computed from the ratio to 1 foot.

4. It is essential that BOTH ends of the cable shields be well grounded.

Figure 3-2

3-13 DIFFERENTIAL MEASUREMENTS

Use the following procedure to determine the capacitance differential between two specimens. The specimens may be biased (para. 3-14) or unbiased, and they can be connected either locally or remotely.

a. Connect the larger value specimen (if known) to the CAPACITANCE TEST HI and LO terminals.

b. Connect the other specimen to the CAPACITANCE DIFF HI and LO terminals.

c. Set the RANGE switch to a position consistent with the value of one of the specimens. If increased resolution is desired, set the RANGE switch to the next lower position, provided the overrange tolerance is not exceeded.

d. Read the capacitance differential directly on the digital display. If a negative readout results, the larger capacitance value is at the CAPACITANCE DIFF terminals, and the two specimens should be interchanged.

3-14 APPLYING DC BIAS

Perform the applicable procedure, below, to bias capacitance specimens that are to be measured on the 700A. In paragraph a, specimens are biased up to ±100 volts by the Model 15A Bias Supply. Use the procedure in paragraph b to apply bias from an external source up to ±200 volts at 250 mA. Paragraph c contains instructions for applying external bias in excess of ±200 volts. In all cases the bias voltage appears across both the CAPACITANCE TEST and DIFF terminals, and the BIAS fuse protects internal circuits for both internal and external bias applications.

a. Applying up to ±100 Volts.

(1) Set the polarity switch on the 15A to the required polarity (pilot lamp should glow). The polarity selected is applied to the CAPACITANCE TEST and DIFF HI terminals.

(2) For maximum stability, allow 30 minutes for bias supply warm-up.

(3) Set the mode switch to V.

(4) Set the voltage range switch to the applicable position.

(5) Adjust the DC LEVEL control until the digital display indicates the required voltage level.

(6) Connect test specimens to the CAPACITANCE TEST or DIFF terminals, as required.

b. Applying Bias up to ±200 Volts.

(1) Set the polarity switch to OFF (EXT BIAS) and perform steps a (3) and (4), above.
(2) Connect the output leads of the bias source to the 71D BIAS binding posts, observing the polarity and ground assignments.
(3) Adjust the external bias source to the required voltage level. Do not apply more than 200 volts at 250 mA or the BIAS FUSE may open. The digital display will readout bias up to 140V (100V + 40% overrange).
(4) Connect test specimens to the CAPACITANCE TEST or DIFF terminals, as required.

c. Applying More Than +200 Volts Bias. When biasing requirements exceed ±200 volts, use the circuit in Figure 3-3 to connect the external bias source to the 700A. Notice that a shorting strap is connected across the 71D BIAS binding posts.

(1) Set the polarity switch to OFF (EXT BIAS).
(2) Adjust the external bias source to the required voltage level.
(3) Connect the biasing circuit (Fig. 3-3) to the HI and LO terminals at either CAPACITANCE TEST or CAPACITANCE DIFF, as convenient.
(4) Connect test specimens in accordance with Figure 3-3.

CONNECTIONS FOR EXTERNAL BIAS (OVER 200 VOLTS)

$C_2 \approx 200(C_{TEST})$, WITH VOLTAGE RATING > E

L_1 & C_1 TO RESONATE @ 1MHz. $Q_{@}\ L_1 > 200K$ ($L_1 \approx 150\mu H$; $Q > 200$)

RC = 0.002 SECONDS.

NOTE: L103 MAY BE USED FOR L1. L103 MAY BE ORDERED FROM BOONTON ELECTRONICS CORP., PART NO. 400124; PRICE $7.50 EACH; MINIMUM ORDER $15.00.

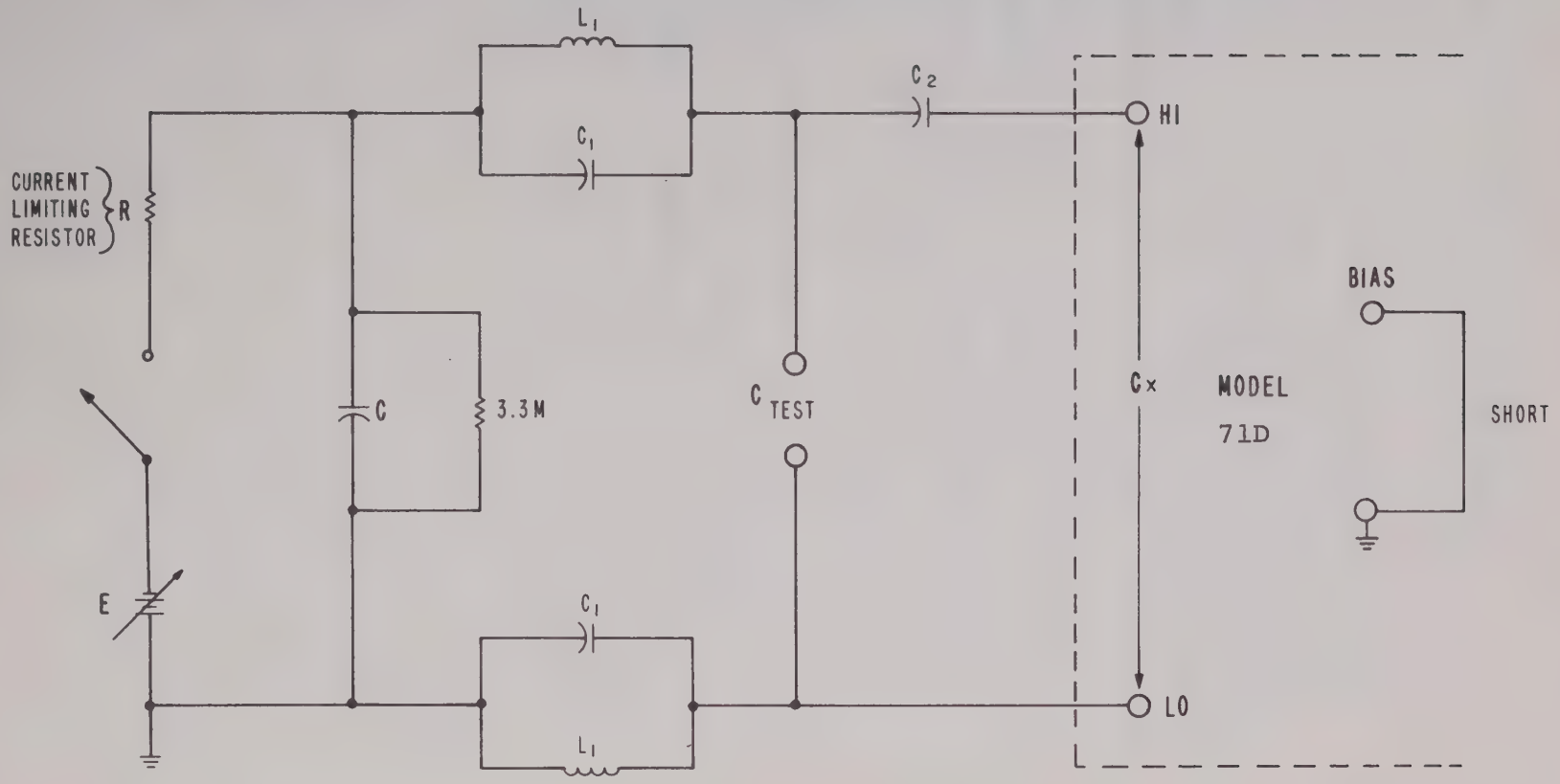


Figure 3-3

Dwg 830374B

Section 111. INDUCTANCE MEASUREMENTS

3-15 MEASUREMENTS

After the preoperational adjustments (para. 3-4) are completed, inductance measurements may be performed in accordance with the procedure given below. When no specimen is connected to the 700A and the RANGE switch is set to a LμH position, a digital display blank-out and an OVERRANGE indication will result. However, the digital display will give a normal readout when an inductance specimen is connected to the 700A. Proceed as follows:

a. Connect a two-terminal inductance specimen directly to the 71D INDUCTANCE HI and GND terminals.
b. Set the RANGE switch to a LμH position consistent with the value of the test specimen.
c. Read the value of the test specimen on the digital display.

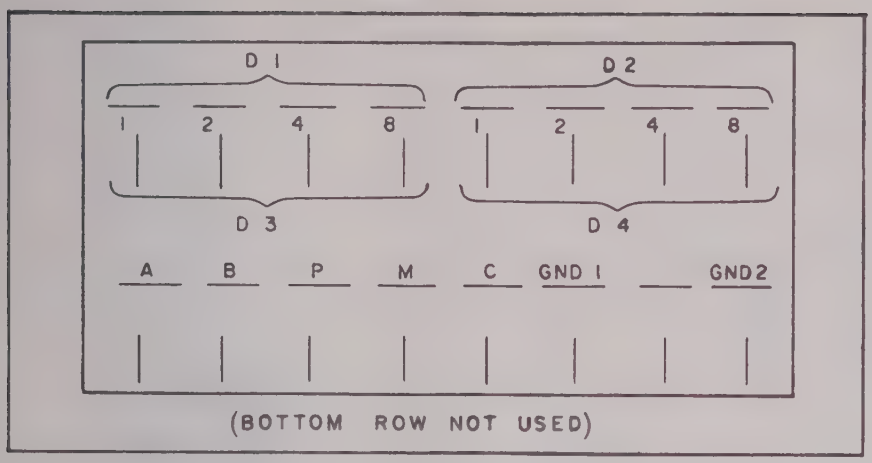
3-16 REMOTE MEASUREMENT CONSIDERATIONS

The 700A will accurately measure inductance values if test specimens are connected directly to the 71D INDUCTANCE HI and GND terminals. However, when a specimen is connected remotely, the connecting leads introduce inductance and capacitance to the measurement, and an erroneous reading will result unless a correction is made. If remote measurements must be performed, refer to Figure 3-4 for error and correction information.

Section IV. SYSTEM APPLICATIONS

A BCD output permits the 700A to be used in system applications, as described in paragraph 1-1. When the 700A is an integral part of a system configuration, it may be remotely controlled and triggered manually, or it can be triggered automatically in synchronism with some system event. Provision also is made to apply a code inhibit input signal to the 700A, if required. This signal can be used to inhibit a conversion process and can eliminate the need for buffer storage. In a typical application, the code-inhibit input signal can be used to momentarily stop the 700A readout until a slower unit, such as a printer or card punch, records data. For system or external requirements, all input and output connections on the 700A are made at receptacle J801, located on the rear panel of the 94A unit. A mating connector is supplied to wire the 700A into the system, as required. Refer to Figure 3-5 for J801 terminal data and information.

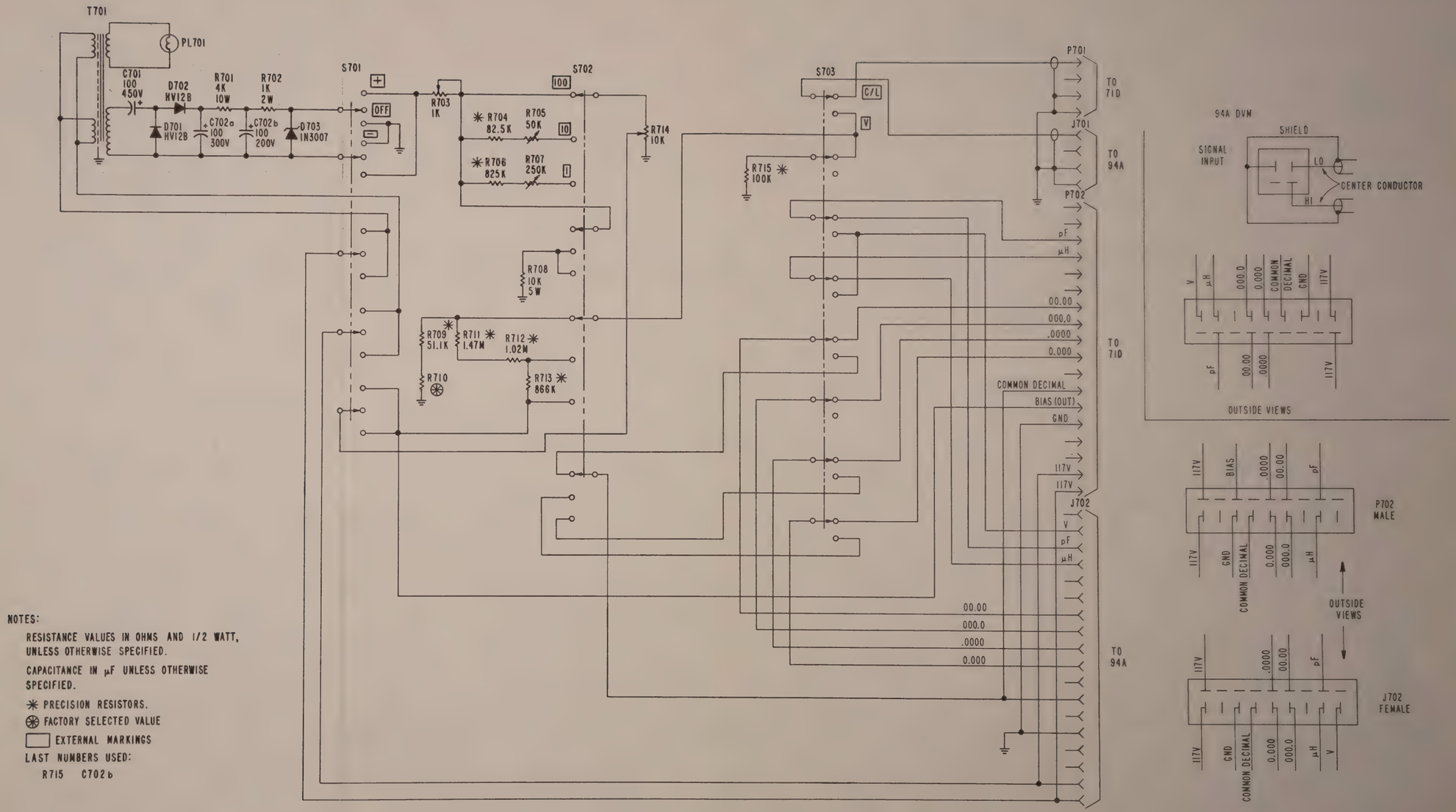
J801



LEGEND FOR J801

J801 Terminals	Remarks
D4 thru D1 (8, 4, 2, 1)	BCD digit outputs; D4 provides the most significant digit, and D1 provides the least significant digit. Logic 1: $\geq$ + 4.0V $Z_o \approx 4\ k\Omega$ Logic 0: $\leq$ + 0.4V $Z_o \approx 100\Omega$ Current Sink = 3.2 mA (max.). All digit and polarity data are stored between completion of successive encode periods.
A	Overrange (=logic 1).
B	Polarity (Logic 1= +, logic 0 =-).
P	Print command. Occurs once each encode period; data storage completed at negative-going edge of a $\simeq$ 150 μsec pulse (fall time $\leq$ 50 μsec).
M	Encode inhibit input. Logic 0 inhibits encode. Logic 1 or open circuit enables encode. (Must be applied within 20 ms after print command.)
C	External trigger input. External closure to pwr Gnd terminal initiates new encode period. (TRIGGER switch must be in EXT position.)
Gnd 1 Gnd 2	Power ground. Chassis ground.

Figure 3-5. Receptacle J801 terminations.



NOTES:

RESISTANCE VALUES IN OHMS AND 1/2 WATT, UNLESS OTHERWISE SPECIFIED.

CAPACITANCE IN μF UNLESS OTHERWISE SPECIFIED.

✳ PRECISION RESISTORS.

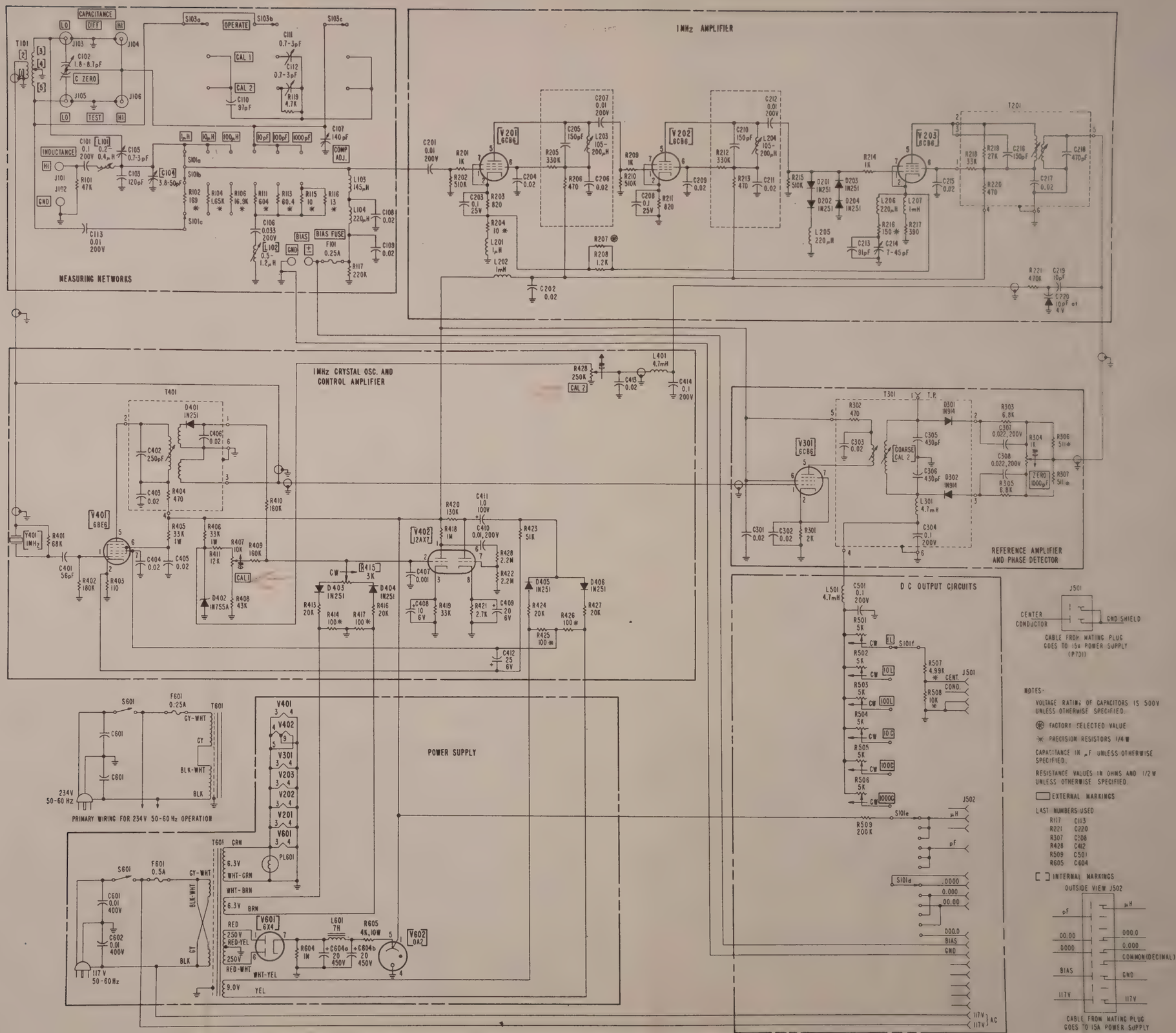
⊛ FACTORY SELECTED VALUE

▭ EXTERNAL MARKINGS

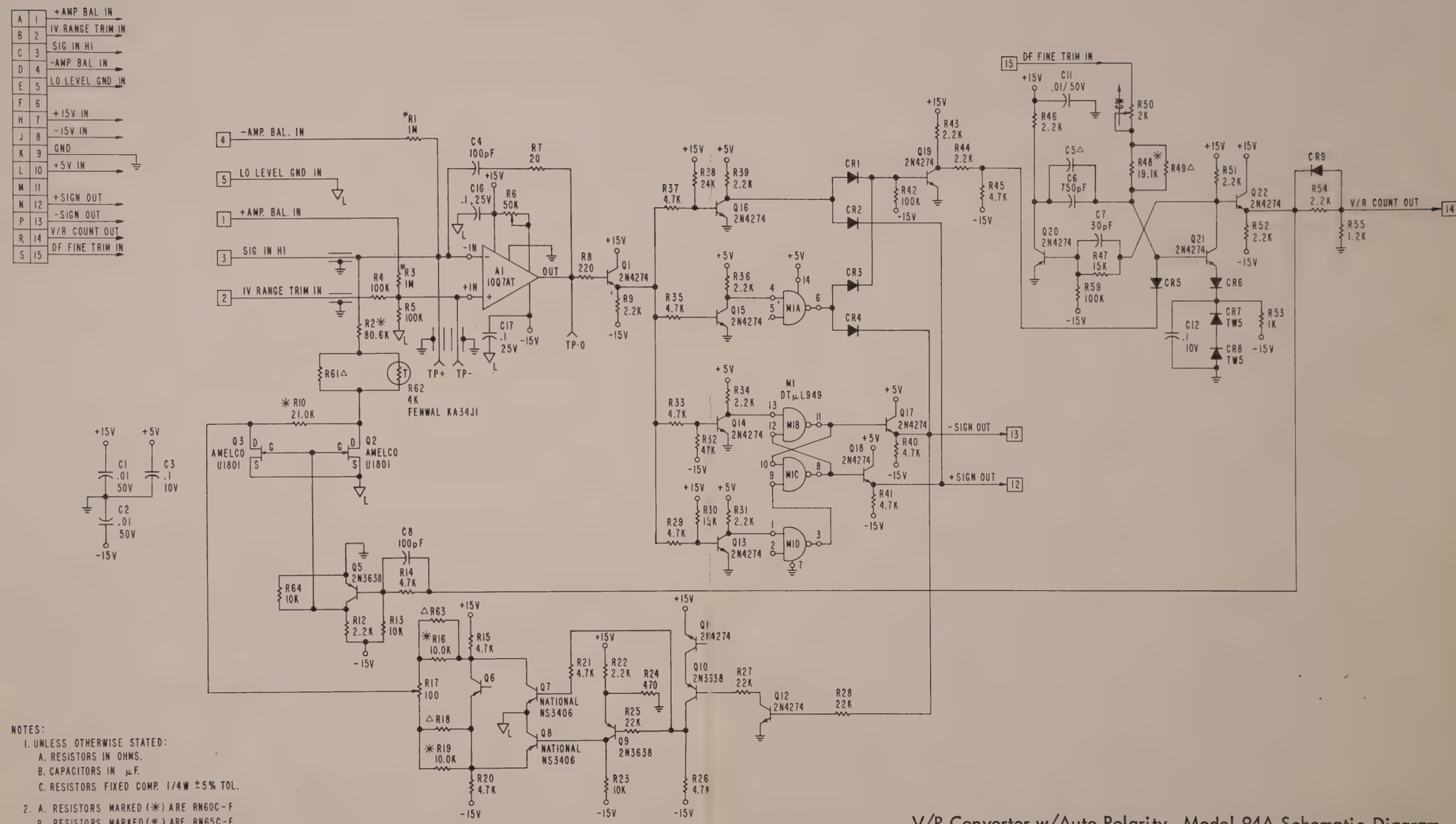
LAST NUMBERS USED:

R715 C702b

Schematic Diagram for Model 15A
(Dwg. No. 830410B)



Schematic Diagram for Model 71D
(Dwg. No. 2000278)

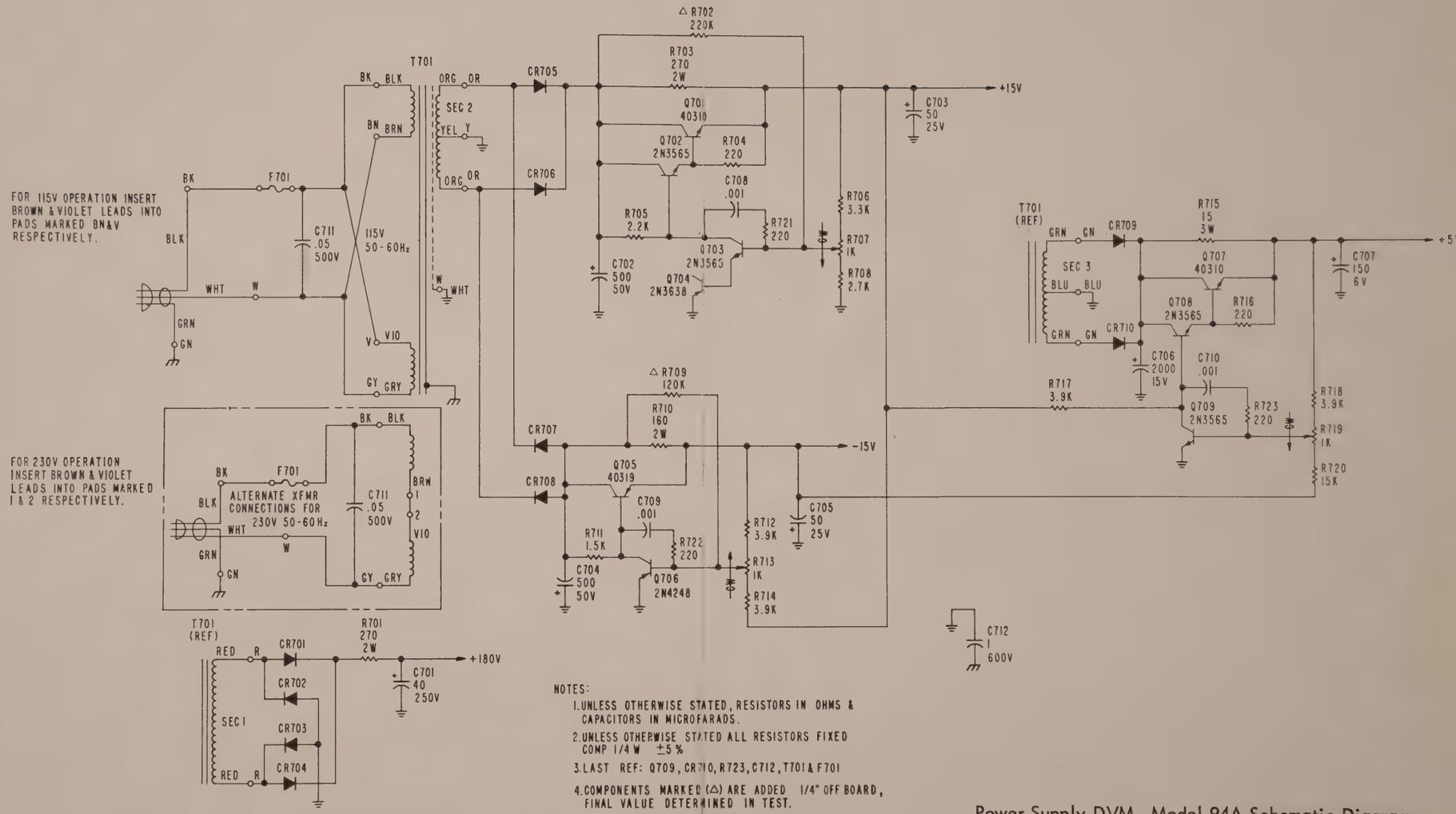


NOTES:

1. UNLESS OTHERWISE STATED:
   - A. RESISTORS IN OHMS.
   - B. CAPACITORS IN μF.
   - C. RESISTORS FIXED COMP. 1/4W ±5% TOL.
2. A. RESISTORS MARKED (✳) ARE RN60C-F
   B. RESISTORS MARKED (✱) ARE RN65C-F
3. COMPONENTS MARKED (△) ARE ADDED IN TEST.
4.
5. LAST REF. A1, Q22, M1, CR9, R64, C17.
6. UNLESS OTHERWISE STATED ALL DIODES ARE IN914

V/R Converter w/Auto Polarity, Model 94A Schematic Diagram

(Dwg. No. 830433A)

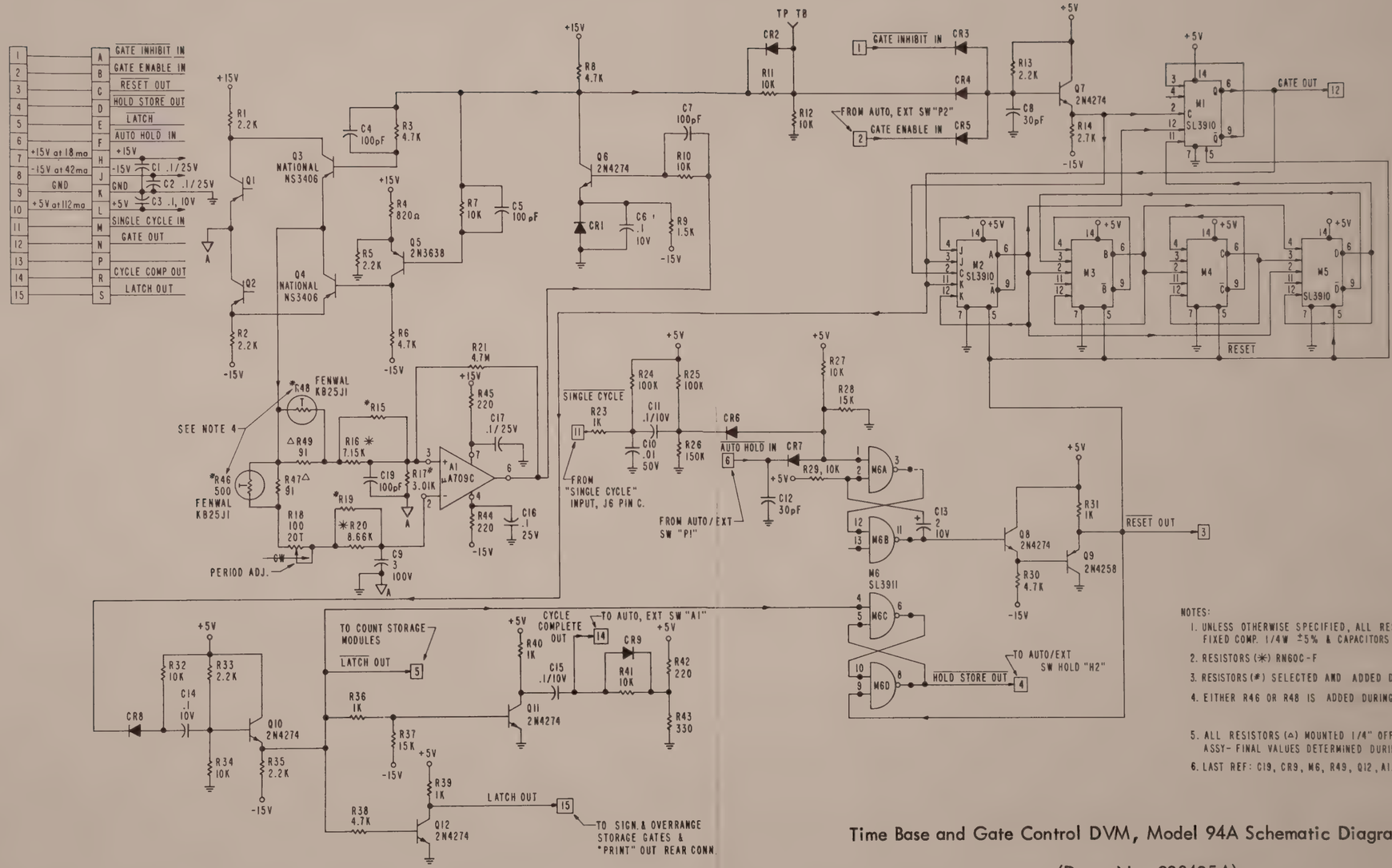


NOTES:

1. UNLESS OTHERWISE STATED, RESISTORS IN OHMS & CAPACITORS IN MICROFARADS.
2. UNLESS OTHERWISE STATED ALL RESISTORS FIXED COMP 1/4 W ±5 %
3. LAST REF: Q709, CR710, R723, C712, T701 & F701
4. COMPONENTS MARKED (△) ARE ADDED 1/4" OFF BOARD, FINAL VALUE DETERMINED IN TEST.

Power Supply DVM, Model 94A Schematic Diagram

(Dwg. No. 830434A)

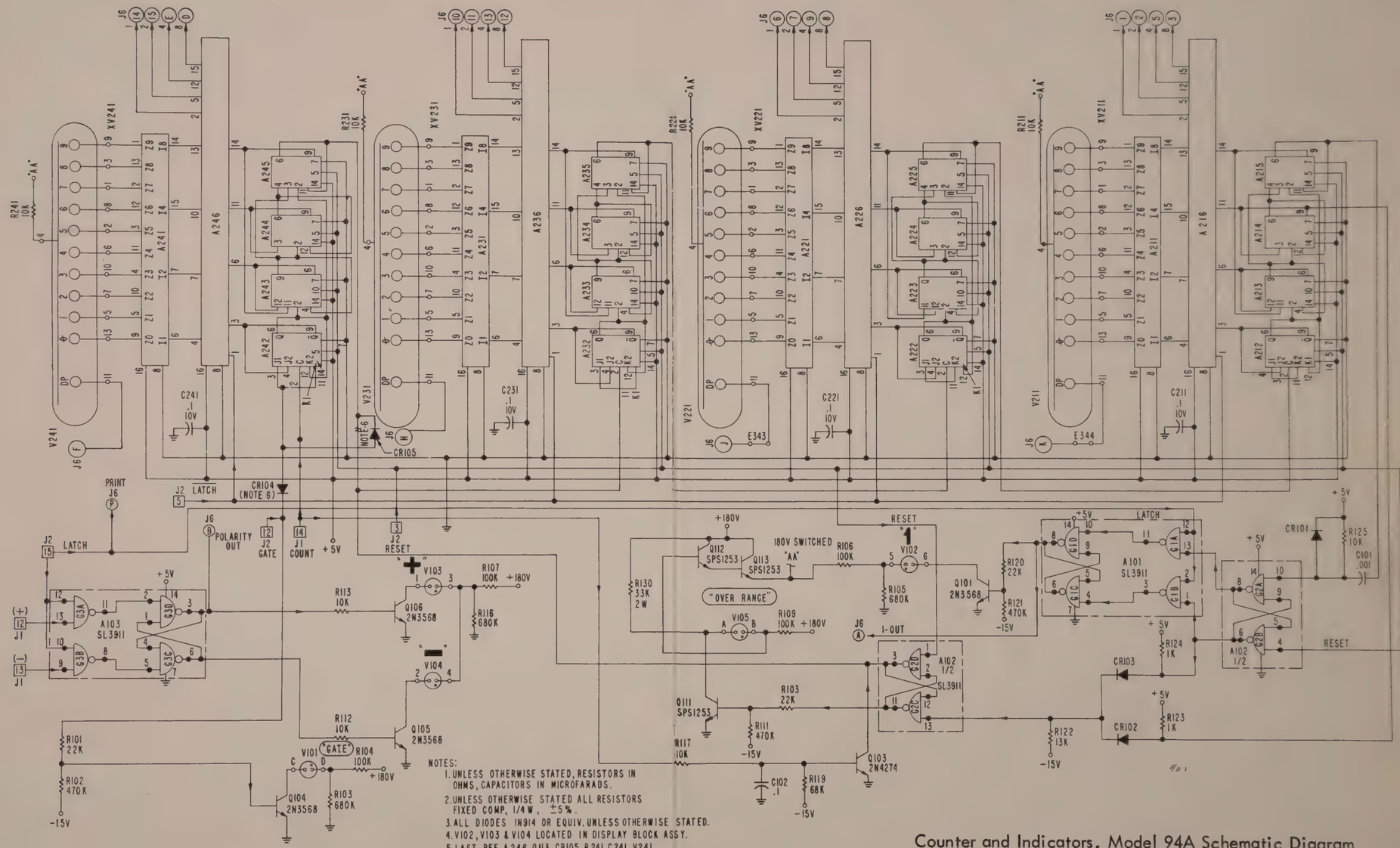


NOTES:

1. UNLESS OTHERWISE SPECIFIED, ALL RESISTORS IN OHMS FIXED COMP. 1/4W ±5% & CAPACITORS IN µF.
2. RESISTORS (✳) RN60C-F
3. RESISTORS (#) SELECTED AND ADDED DURING TEST.
4. EITHER R46 OR R48 IS ADDED DURING TEST- NOT BOTH
5. ALL RESISTORS (△) MOUNTED 1/4" OFF BOARD DURING ASSY- FINAL VALUES DETERMINED DURING TEST.
6. LAST REF: C19, CR9, M6, R49, Q12, A1.

Time Base and Gate Control DVM, Model 94A Schematic Diagram

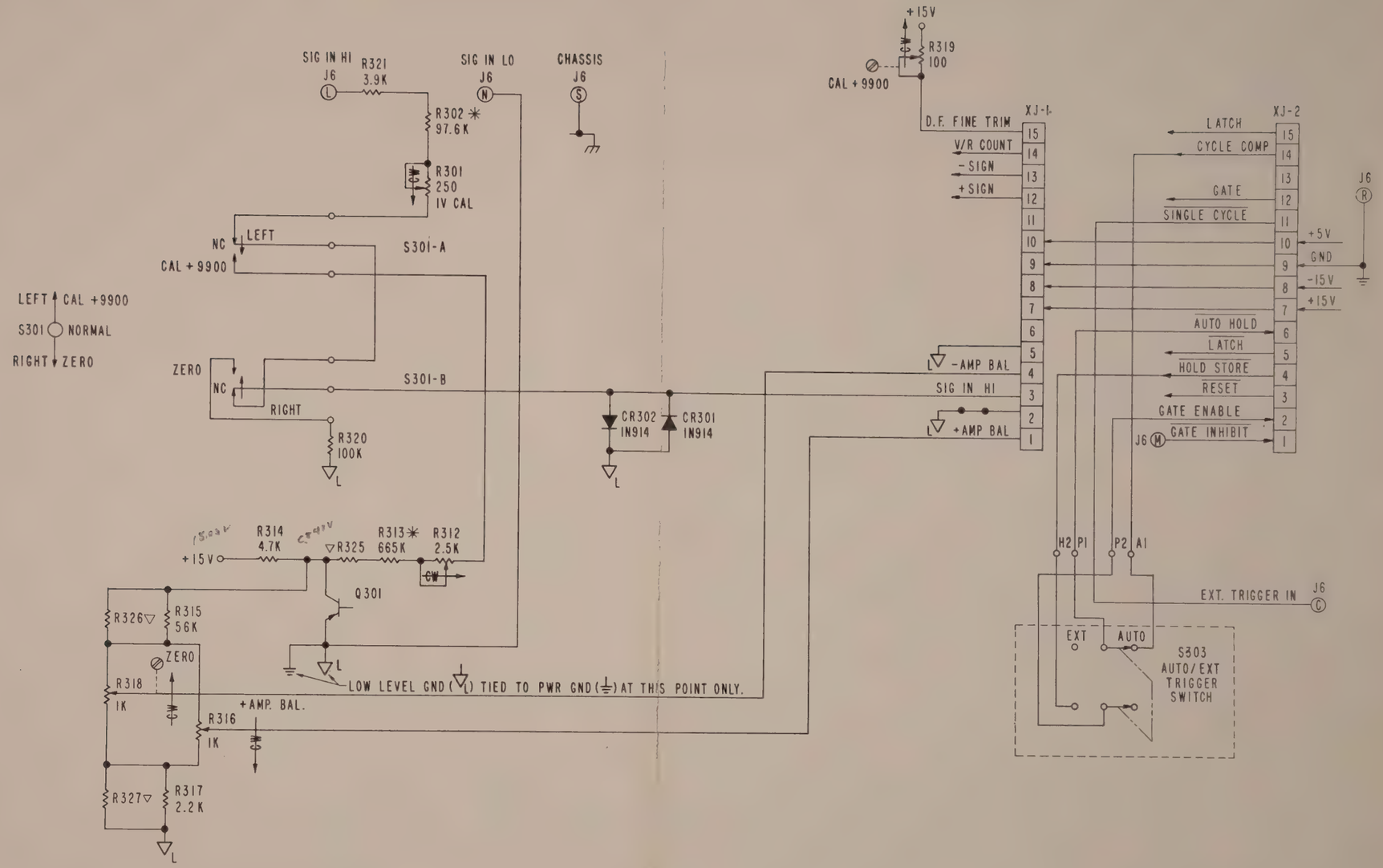
(Dwg. No. 830435A)



NOTES:
1. UNLESS OTHERWISE STATED, RESISTORS IN OHMS, CAPACITORS IN MICROFARADS.
2. UNLESS OTHERWISE STATED ALL RESISTORS FIXED COMP, 1/4 W, ±5%.
3. ALL DIODES IN914 OR EQUIV. UNLESS OTHERWISE STATED.
4. V102, V103 & V104 LOCATED IN DISPLAY BLOCK ASSY.
5. LAST REF. A246, Q113, CR105, R241, C241, V241
6. CR104, CR105, GERMANIAN DIODE IN67A OR EQUIV.

Counter and Indicators, Model 94A Schematic Diagram

(Dwg. No. 830436A)



NOTES:

1. ALL RESISTORS ARE IN OHMS AND 1/4W, ±5% UNLESS OTHERWISE SPECIFIED.
2. ALL ✳ ARE RN65C ±1%
3. COMPONENTS (▽) ADDED IN TEST.
4. LAST REF. Q301, CR302, S303, R327

Range and Mode Switching, Model 94A Schematic Diagram

(Dwg. No. 830437A)

Warranty

Boonton Electronics Corporation warrants its products to the original purchaser to be free from defects in material and workmanship and to operate within applicable specifications for a period of one year from date of shipment, provided they are used under normal operating conditions. This warranty does not apply to vacuum tubes that have given normal service, to sealed assemblies which have been opened, or to any item which has been repaired or altered without our authorization.

We will repair or, at our option, replace at no charge any of our products which are found to be defective under the terms of this warranty.

SHIPPING INSTRUCTIONS

If the instrument must be returned to the manufacturer, observe the applicable instructions below to ensure safe shipment.

a. Use the original packing material, if available, and pack in accordance with the reshipment instructions in this manual. The manufacturer will supply packing material at nominal cost, if desired. Contact the Sales Department, Boonton Electronics Corporation, Route 287 at Smith Road, Parsippany, N.J. 07054.

b. Alternately, wrap the instrument in heavy wrapping paper and seal the seams with gummed tape. Place the instrument in a fiberboard carton large enough to accommodate three inches of soft padding material. Seal well.

BOONTON ELECTRONICS CORPORATION
PARSIPPANY, NEW JERSEY

Domestic Price List
Instruments & Accessories

Effective Date, January 15, 1969
Superseding issue of December 15, 1967

INSTRUMENTS

Model	Unit Price	Description
1A	$2,750.00	RF Admittance Bridge (0 to 150 pF, 0 to 25 mmhos)
1B	3,300.00	RF Admittance Bridge (0 to 150 pF, 0 to 5 mmhos)
1C	2,950.00	RF Admittance Bridge (0 to 15 pF, 0 to 25 mmhos)
1D	3,500.00	RF Admittance Bridge (0 to 15 pF, 0 to 5 mmhos)
3A	On request	Q Bridge
4A	600.00*	RF Microwattmeter (less 41-4A or 41-4B Power Detector)
4A	160.00	Power Detector for 41A (0.2 MHz to 7 GHz)
4B	250.00	Power Detector for 41A (0.2 MHz to 12.4 GHz)
5A	495.00*	DC Null Detector, 10 Megohm Input
5A-S2	550.00*	DC Null Detector, 40 Megohm Input
5H	2,500.00	Inductance Bridge (5-500 KHz)
5L	2,750.00	Inductance Bridge (0.4 to 40 KHz)
5M	2,500.00	Inductance Bridge (1-100 KHz)
71A	950.00	Capacitance/Inductance Meter (1 MHz)
71AR	1,025.00	Rack Mounting Model 71A
71CR	1,100.00	Capacitance/Inductance Meter (100 KHz, Rack Mtg. Mod.)
170A	2,500.00	Digital Capacitance/Inductance Meter (1 MHz)
74D	1,800.00	Capacitance Brdige (100 KHz; 0.1%, dc bias)
74C	2,300.00	Capacitance Bridge (5-544 KHz; dc bias)
74D	1,800.00	Capacitance Bridge (1 MHz; dc bias)
75B	2,500.00	Automatic Capacitance Limit Bridge (1 MHz)
75B-S1	2,500.00	Automatic Capacitance Limit Bridge (100 KHz)
91C	550.00*	RF Voltmeter (3 mV to 3V, 5% incl. Probe Tip, 50Ω Adapter)
91C-S4	680.00*	RF Voltmeter (91C, with 400 Hz power)
91C-S5	680.00*	RF Voltmeter (91C, with dBm scale)
91C-S7	680.00*	RF Voltmeter (91C, with 400 Hz power & dBm scale)
91DA	700.00*	RF Voltmeter (1 mV to 3V, 2% incl. Probe Tip, 50Ω Adapter)
91DA-S5	700.00*	RF Voltmeter (91DA, with dBm scale)
91H	650.00*	RF Voltmeter (1 mV to 3 V, 3%, incl. Probe Tip, 50Ω Adapter)
91H-S4	780.00*	RF Voltmeter (91H, with 400 Hz power)
91H-S5	650.00*	RF Voltmeter (91H, with dBm scale)
91H-S7	780.00*	RF Voltmeter (91H, with 400 Hz power & dBm scale)
91K	680.00*	Hi Z RF Millivoltmeter (10 mV to 30 V, incl. Probe Tip, 50Ω Adapter)
91K-S1	680.00*	Hi Z RF Millivoltmeter (91K, with dBm scale)
91K-S2	810.00*	Hi Z RF Millivoltmeter (91K, with 400 Hz power)
91K-S3	810.00*	Hi Z RF Millivoltmeter (91K, with 400 Hz power and dBm scale)
91L	975.00*	Microwave Millivoltmeter (1 mV to 1V with two Probes)
91L-S1	975.00*	Microwave Millivoltmeter (91L, with dBm scale)
91L-S2	1,105.00*	Microwave Millivoltmeter (91L, with 400 Hz power)
91L-S3	1,105.00*	Microwave Milivoltmeter (91L, with 400 Hz power and dBm scale)
96A	600.00*	Sensitive DC Meter

Complete Accessory Kit, (when purchased with any of the above RF Voltmeters) — price $125. Includes 91-6C; 91-7C; 91-14A; 91-15A; 91-18A; and storage space for Probe, Tip, and 50Ω Adapter, provided with each instrument.

There are many special versions of instruments, designated by S numbers, not shown. Prices of these units will be quoted on request.

) Hz (117V or 230V) versions of all instruments available at no extra cost.
dd $50.00 for special paint.
Add $25.00 for rack mounting version.
or prices of RF Voltmeter and Bridge Accessories see reverse side.

VOLTMETER AND POWER METER ACCESSORIES

Model	Unit Price	Description
41-2A	15.00	Power Detector Cable for 41A
91-4C	$100.00	Special 1 KHz-250 MHz RF Probe
91-6C	25.00	Unterminated Adapter (BNC)
91-7C	50.00	100:1 Voltage Divider
91-8B	35.00	50Ω Adapter (BNC)
91-8B/1	50.00	75Ω Adapter (BNC)
91-8B/2	50.00	93Ω Adapter (BNC)
91-8B/3	50.00	72Ω Adapter (BNC)
91-8B/4	50.00	90Ω Adapter (BNC)
91-8B/5	50.00	95Ω Adapter (BNC)
91-8B/6	50.00	60Ω Adapter (BNC)
91-8B/7	50.00	20Ω Adapter (BNC)
91-8B/8	50.00	200Ω Adapter (BNC)
91-8B/9	50.00	52Ω Adapter (BNC)
91-12D	75.00	RF Probe**
91-12E	65.00	RF Probe for all current RF Voltmeters
91-13B	5.00	Probe Tip
91-14A	55.00	"Tee" Adapter (Type N)
91-15A	35.00	50Ω Termination for 91-14A (Type N)
91-16A	25.00	Unterminated Adapter (Type N)
91-17D	100.00	Special 1 KHz-250 MHz RF Probe**
91-18A	15.00	Accessory Storage Box
91-19B	15.00	Accessory Storage Bracket

** For replacement in Model 91DA's with Serial Numbers below 8535 only.

BRIDGE ACCESSORIES

CS	$100.00	Capacitance Standard for 74, 75, & 77 Series
TS1	5.00	Terminal Shield
33-1A	60.00	Dielectric Sample Holder for Model 33 Series
33-2A	60.00	Diode Test Jig for Model 33 Series
33-3A	60.00	Type N 50Ω Adapter for Model 33 Series
33-4A	120.00	Set of 7 work coils (with storage container) for capacitance measurement with Models 33A and 33B
33-5A	120.00	Set of 7 work coils (with storage container) for capacitance measurement with Models 33C and 33D
33-6A	120.00	Set of 7 work coils (with storage container) for inductance measurement with Models 33A and 33B
33-7A	120.00	Set of 7 work coils (with storage container) for inductance measurement with Models 33C and 33D
33-8A	40.00	Zero Conductance Standard
33-9A/1	30.00	5 pF Capacitance Standard for Model 33 Series
33-9A/2	30.00	10 pF Capacitance Standard for Model 33 Series
33-9A/3	30.00	20 pF Capacitance Standard for Model 33 Series
33-9A/4	30.00	30 pF Capacitance Standard for Model 33 Series
33-9A/5	30.00	50 pF Capacitance Standard for Model 33 Series
33-9A/6	30.00	75 pF Capacitance Standard for Model 33 Series
33-9A/7	30.00	100 pF Capacitance Standard for Model 33 Series
33-9A/8	30.00	125 pF Capacitance Standard for Model 33 Series
33-9A/9	30.00	145 pF Capacitance Standard for Model 33 Series
33-10A/1	30.00	20 mmho Conductance Standard for Models 33A and 33C
33-10A/2	30.00	10 mmho Conductance Standard for Models 33A and 33C
33-10A/3	30.00	1 mmho Conductance Standard for Models 33A and 33C
33-10A/4	30.00	100 μmho Conductance Standard for Models 33A and 33C
33-10A/5	30.00	10 μmho Conductance Standard for Models 33A and 33C
33-10A/6	30.00	4 mmho Conductance Standard for Models 33B and 33D
33-10A/7	30.00	2 mmho Conductance Standard for Models 33B and 33D
33-10A/8	30.00	200 μmho Conductance Standard for Models 33B and 33D
33-10A/9	30.00	20 μmho Conductance Standard for Models 33B and 33D
33-10A/10	30.00	2 μmho Conductance Standard for Models 33B and 33D
33-11A/1	30.00	225 pF Range Extending Capacitor for 33A and 33B
33-11A/2	30.00	375 pF Range Extending Capacitor for 33A and 33B
33-11A/3	30.00	525 pF Range Extending Capacitor for 33A and 33B
33-11A/4	30.00	675 pF Range Extending Capacitor for 33A and 33B
33-11A/5	30.00	825 pF Range Extending Capacitor for 33A and 33B
33-11A/6	30.00	975 pF Range Extending Capacitor for 33A and 33B
33-11A/7	30.00	1125 pF Range Extending Capacitor for 33A and 33B
33-11A/8	30.00	1275 pF Range Extending Capacitor for 33A and 33B
33-11A/9	30.00	1425 pF Range Extending Capacitor for 33A and 33B

BRIDGE ACCESSORIES

Model	Unit Price	Description
33-2A/1A	25.00	Range Extending Coil for use with 33-11A/1 at 1 MHz on 33A and 33B
33-2A/1B	25.00	Range Extending Coil for use with 33-11A/2 at 1 MHz on 33A and 33B
33-2A/1C	25.00	Range Extending Coil for use with 33-11A/3 at 1 MHz on 33A and 33B
33-2A/1D	25.00	Range Extending Coil for use with 33-11A/4 at 1 MHz on 33A and 33B
33-2A/1E	25.00	Range Extending Coil for use with 33-11A/5 at 1 MHz on 33A and 33B
33-2A/1F	25.00	Range Extending Coil for use with 33-11A/6 at 1 MHz on 33A and 33B
33-2A/1G	25.00	Range Extending Coil for use with 33-11A/7 at 1 MHz on 33A and 33B
33-2A/1H	25.00	Range Extending Coil for use with 33-11A/8 at 1 MHz on 33A and 33B
33-2A/1J	25.00	Range Extending Coil for use with 33-11A/9 at 1 MHz on 33A and 33B
33-2A/2A	25.00	Range Extending Coil for use with 33-11A/1 at 5 MHz on 33A and 33B
33-2A/2B	25.00	Range Extending Coil for use with 33-11A/2 at 5 MHz on 33A and 33B
33-2A/2C	25.00	Range Extending Coil for use with 33-11A/3 at 5 MHz on 33A and 33B
33-2A/2D	25.00	Range Extending Coil for use with 33-11A/4 at 5 MHz on 33A and 33B
33-2A/2E	25.00	Range Extending Coil for use with 33-11A/5 at 5 MHz on 33A only
33-2A/2F	25.00	Range Extending Coil for use with 33-11A/6 at 5 MHz on 33A only
33-2A/2G	25.00	Range Extending Coil for use with 33-11A/7 at 5 MHz on 33A only
33-2A/2H	25.00	Range Extending Coil for use with 33-11A/8 at 5 MHz on 33A only
33-2A/2J	25.00	Range Extending Coil for use with 33-11A/9 at 5 MHz on 33A only
33-2A/3A	25.00	Range Extending Coil for use with 33-11A/1 at 10 MHz on 33A and 33B
33-2A/3B	25.00	Range Extending Coil for use with 33-11A/2 at 10 MHz on 33A and 33B
33-2A/3C	25.00	Range Extending Coil for use with 33-11A/3 at 10 MHz on 33A only
33-2A/3D	25.00	Range Extending Coil for use with 33-11A/4 at 10 MHz on 33A only
33-2A/3E	25.00	Range Extending Coil for use with 33-11A/5 at 10 MHz on 33A only
33-2A/3F	25.00	Range Extending Coil for use with 33-11A/6 at 10 MHz on 33A only
33-2A/3G	25.00	Range Extending Coil for use with 33-11A/7 at 10 MHz on 33A only
33-2A/3H	25.00	Range Extending Coil for use with 33-11A/8 at 10 MHz on 33A only
33-2A/3J	25.00	Range Extending Coil for use with 33-11A/9 at 10 MHz on 33A only
33-2A/4A	25.00	Range Extending Coil for use with 33-11A/1 at 20 MHz on 33A and 33B
33-2A/4B	25.00	Range Extending Coil for use with 33-11A/2 at 20 MHz on 33A only
33-2A/4C	25.00	Range Extending Coil for use with 33-11A/3 at 20 MHz on 33A only
33-2A/5A	25.00	Range Extending Coil for use with 33-11A/1 at 30 MHz on 33A only
33-13A	15.00	Storage Case for 8 work coils for 33 Series
33-14A	400.00	Complete set of 33-9A and 33-10A Standards in storage case for 33A
33-15A	25.00	Test Signal Attenuator for use with 33C
33-16A	400.00	Complete set of 33-9A and 33-10A Standards in storage case for 33B
33-17A	260.00	Complete set of 33-9A Capacitance Standards for 33A and 33B
33-18A	140.00	Complete set of 33-10A Conductance Standards for 33A and 33C
33-19A	140.00	Complete set of 33-10A Conductance Standards for 33B and 33D
63-11B	100.00	Mu Jig for use with 63H, 63L, or 63M
63-15A	100.00	Inductance Standard (1 μH)
71-1A	60.00	100 pF Capacitance Standard & Q Check for Model 71A
71-2A/1	75.00	1 pF plug-in Capacitance Standard for Models 71A and 700A.
71-2A/2	75.00	3 pF plug-in Capacitance Standard for Models 71A and 700A.
71-2A/3	75.00	10 pF plug-in Capacitance Standard for Models 71A and 700A.
71-2A/4	75.00	30 pF plug-in Capacitance Standard for Models 71A and 700A.
71-2A/5	75.00	100 pF plug-in Capacitance Standard for Models 71A and 700A.
71-2A/6	75.00	300 pF plug-in Capacitance Standard for Models 71A and 700A.
71-2A/7	75.00	1000 pF plug-in Capacitance Standard for Models 71A and 700A.
71-3A	on request	Decade Capacitor (0 to 1,111 pF, in 1 pF steps)
71-4A	120.00	Capacitance Range Divider (10:1, 1 MHz) for 71A and 700A.
71-5A	120.00	Capacitance Range Divider (10:1, 100 KHz) for 71CR
71-6A	160.00	Capacitance Test Terminal Extender (1 MHz)
71-7A	125.00	Inductance Test Terminal Extender (1 MHz)
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This 71A procedure applies to the 700A and 700C Digital C/L Meters as well. The bottom racks of these units are the 71D and 71E respectively and may be calibrated using this procedure while keeping in mind the different physical configuration. Also the 71D and 71E sections contain an internal calibration standard.

The DVM section of the 700A or 700C may be calibrated by applying a known 1V across the EXT BIAS posts with the unit controls set to read out external bias.

Normally, if the instrument is performing properly but appears to be out of calibration, then proceed directly to 4. PRELIMINARY CALIBRATION. Cable length precautions and COMP ADJ. procedures as outlined in the Operator's Manual should be observed.

This procedure should not be used indiscriminately as an overall periodic alignment. It should be used only for those instruments which exhibit problems and must be turned around more quickly than a factory repair.

Yours very truly,

BOONTON ELECTRONICS CORPORATION

Ed Vose
Sales Engineer

EV:kd

Enclosures

C/L METER MODEL 71

TEST EQUIPMENT

Digital Voltmeter Fluke 8100a or equivalent
Oscilloscope Telequipment S32 or equivalent
Boonton RF Voltmeter Model 91DA with 100:1 divider
One set of 7 CS Capacitance Standards
(1, 3, 10, 30, 100, 300 and 1000 pF)
One set of 7 Inductance Standards
(1, 3, 10, 30, 100, 300, and 1000 μH)
Two Low Q Capacitance Standard (100 and 1000 pF)
One Capacitance Switch Standard (10 pF steps, 100 pF total)
One Low Q Inductance Standard (1000μH)
battery supply 0.75 VDC ± 5%

1. VISUAL INSPECTION (FOR CALIBRATION, PROCEED DIRECTLY TO [illegible])

a. Chassis
Check condition of chassis and record chassis number.

b. Panel
Check condition of panel.

c. Range Knob Alignment
Check that the range knob is centered on ranges, does not rub, and that all set screws are tight.

d. Inductance Terminals
Check that the holes in the Inductance Terminals are parallel to the base of the instrument.

e. Inspection Stamp
Check for inspection stamp on chassis.

f. Fuses
Check that the fuse in the ON/OFF switch is a 1/2 A Slo-Blo for 117v units and 1/4 A Slo-Blo for 220 V units. Check that the rear fuse in the bias circuit is a normal 1/4 A fuse.

g. Meter Zero
Check that the mechanical meter zero is adjustable through zero and set adjustment to zero.

h. DC Output Resistor
Connect a 1.1 megohm resistor across the DVM terminals on the rear of the chassis.

i. Pot Lock Nuts
Check that the lock nuts are finger tight, and all pot shafts turn with a screwdriver. Set all pots to mid-

i. Pot Lock Nuts (cont'd)
value except R407, R415 100C, and 1000C which are set fully counter clockwise.

j. Phase Transformer Adjustments Nuts
Place two 6/32 X 1/4 nuts on the T301 top slug of the phase transformer. See Figure 1.

2. SHOCK HAZARD
Clip black lead from T 52 Chassis Ground Tester to chassis of 71. Plug 71 into T 52 socket and observe that only the Green lamp lights. Check with ON switch in both ON and OFF positions.

3. ELECTRICAL MEASUREMENTS
Connect the 71 to 117 VAC and turn on.
Note: all measurements are made with respect to ground except as noted.

a. Unregulated DC
Measure the DC voltage at the left lead of R605 (4K.10W). It should be about 275 V. See figure 1.

b. Regulated DC
Measure the DC voltage at the junction of three red wires on small p/c board. It should be about 150 V. See Figure 1.

c. Zener Voltage
Measure the DC voltage at the upper lead of R406 (6.8K, large p/c board). It should be about 7.5 V. See Figure 1.

d. Oscillator Control Adjustment
Connect the negative side of 0.75 VDC ± 5% to the Oscillator Bias point, the negative side of C412 (25μF, 6V). (See Figure 1) Connect the positive side to ground. Connect 91DA RF Voltmeter to the LO Test post. Adjust the slug on T401 for a maximum indication on the 91DA. Withdraw slug counterclockwise for an indication of 15mV on the 91DA. Measure the DC reference voltage at pin 1 of T401. See Figure 1. It should be about 5.5 V.
Adjust the Oscilloscope for a horizontal display of 2 or 3 cycles of line frequency and a vertical display of 5 volts/cm. Connect the Oscilloscope probe to the negative side of C411 (25μF Capacitor on the Large P.C. Board) See Figure 1. Adjust R407

d. Oscillator Control Adjustment (cont'd)
(Cal 1 on 71 D and E) for a waveform similar to Fig. 3. Adjust R415 for a wave form similar to Fig. 4. Repeat these two adjustments until the waveform is reduced to approximately zero. See Fig. 5. Remove bias voltage and scope probe.

e. RF Reference Voltage
Connect the 91DA with a 100:1 voltage divider to pin 1 of T301. See Fig. 1. Adjust slug 1 of T301 until it protrudes approximately 1/8 inch beyond rear chassis. Adjust slug 2 for a maximum indication on the 91DA.

f. Open Loop Gain
Remove the yellow feedback loop lead from pin 1 of TBI and solder to a ground on V201 tube socket. See Fig. 1. Loosely couple the 91DA with the 100:1 Voltage Divider to the output of V203, by clipping the probe tip to the teflon sleeving covering the wire from pin 2 of T201 to pin 5 of V203. Connect a jumper wire from the center tap of R304 to ground. See Fig. 1. Set the 71 to the 100pF Capacitance Range Connect approximately 10pF across the capacitance test posts. Loosen the adjustment lock nuts on L203 & 204. (for coil, transformer, and adjustment location) See Fig. 1 & 2. In sequence, adjust L203, L204, C214, and the bottom slug of T201 for a maximum 91DA indication. Remove the 10pF from the Capacitance Test posts and adjust the front panel C zero for a null on the 91DA. Reconnect the 10pF Capacitor to the C test posts and repeat the adjustment of L203, L204, C214, and T201. Lock L203 and L204 adjustments with the lock nuts making certain the adjustments do not change position by observing 91DA meter indication. The output level as indicated on the 91DA should be approximately 1.5 VRMS. Remove the short from R304 and adjust the top slug of T201 for a null indication on the 91DA. Remove the 91DA Probe and the 10pF test Capacitor. Unsolder the yellow feedback wire from V201 ground and resolder to pin 1 of TB1.

g. Closed Loop Gain
With the 71 meter switch in the OFF position check the mechanical meter zero. Set meter switch to ON. Set the 71 to the 1000pF position and adjust R304 for a meter zero. Set the 71 to the 1pF range and adjust the front panel C zero for a meter zero. Repeat both zero adjustments if required. Set the 71 to the 100pF range, and connect a 100pF standard to C test terminals. Alternately adjust C 214 and

g. Closed Loop Gain (cont'd)
slug 1 of T301 until a maximum meter indication is obtained. Remove the 100pF standard and readjust the 1000pF zero and the front panel C zero.

4. PRELIMINARY CALIBRATION

a. Comp Adj
Set the 71 to the 1pF range and connect a 1pF standard to the C test post using B N C.Cables approximately 6" long. Adjust the Comp. Adjust for a maximum meter indication. It may be necessary to adjust the front panel C zero to keep the meter reading on scale. Disconnect the low post lead and readjust the C zero for a meter zero.
NOTE: These cables must be used for the balance of the Capacitance Calibration procedure.

b. 100pF Hi Lo Q Adjustment
Set the 71 to the 100pF range. Connect a Hi Q 100pF Capacitor to the C test post, and observe reading. Replace the Hi Q Capacitor with a 100pF Lo Q Capacitor (Q=3) and adjust slug 1, of T301 for the same meter indication. Repeat until both readings agree.

c. 1000pF Hi Lo Q Adjustment
Set the 71A to the 1000pF range. Repeat 4 b using 1000pF Hi Lo Q Capacitor and adjustment L102. See Fig. 2.

d. C Range Calibration
Recheck the 1000pF zero and the 1pF zero. Calibrate each Capacitance Range by connecting a Capacitance standard of full scale value, Adjust the proper full scale adjustment for each range.

e. Inductance Zero
Set 71 to the 1μH Range. Place a length of #22 Buss wire directly across the inductance test posts and adjust L101 for a meter indication of 1 small division. Remove the Buss wire.

f. 1000μH Hi Lo Q Adjustment
Set the 71 to 1000μH. Adjust C105 for approximately a 1/2 inch protrusion. See Fig. 2. Connect a high Q 1000μH standard to the inductance test posts and adjust C104 for a full scale meter indication. See Fig. 2. Replace the standard with a 1000μH Low Q Standard (Q=3) and adjust C105 for a full scale meter indication. Repeat both adjustments until both readings agree. Replace the 1000μH standard with a 300μH standard and adjust 1000L for a meter indication of 300μH. Repeat all of the above adjustments if required.

g. L Range Calibration

Calibrate each inductance range by connecting an inductance standard of full scale value. Adjust the proper full scale adjustment for each range.

5. D C OUTPUT CALIBRATION

a. Selection of R522

Connect a resistance substition box, with a range of 330K to 1.5 M on the 5th wafer of the range switch. See Fig. 2. Set resistance to 510K. Connect the DVM to the DVM Binding posts on rear of 71. Set the 71 to the 1000pF range and adjust the 1000pF zero for a DVM zero. Switch to the 300pF range and adjust the front panel C zero for a DVM zero. If 71 meter does not read zero recheck mechanical meter zero. Connect a 300pF standard to the C test posts and adjust 300C for an exact full scale indication. Adjust the DVM Adj. for a DVM Reading of 300mV. Switch to the 1000pF range and connect a 1000pF standard to the C test posts. Adjust 1000C for an exact full scale reading. The DVM should read 1000MV $\pm$ 0.2% if the DVM reading is out of tolerance select another value of resistance for R522 and repeat 5a. Install a resistor of the selected value on range switch and recheck as above.

b. Selection of R523

Connect a resistance substitution box with a range of 160 Ω to 620 Ω to terminals of the terminal strip mounted on DVM Ground post. See Fig. 2. Set to 510 Ω. Set the 71 to 1000pF and connect a 1000pF standard to the C test post. Observe the DVM Reading. Switch the meter switch to OFF. The DVM should indicate the same reading as above. If not select another value of R523 and repeat test. Solder in the selected value, and recheck as above.

6. AGING

Fasten the chassis in its case with all screws tight. Connect to 115 V line. Cycle age for 5 days longer. (see PED #71-8.)

7. STABILITY

Reconnect DVM to DVM output terminals. Set 71 to the 100pF range and the 100pF standard to Test posts. Adjust 100C pot for full scale reading. Observe change in 71 reading from a line voltage of 105 VAC to 125 VAC. Allow two minutes after changing for stabilizing..

71D And 71E Only:

If change is greater then the allowable tolerance change the setting of R602 and repeat test.

8. FINAL CALIBRATION

a. Oscillator Stability Test

Connect the 91DA RF Voltmeter to the Lo C Test post

a. Oscillator stability test (cont'd)
and measure the test level. (15 mV ± 1 mV).
Decrease the line voltage to the 71 by 25%. The test level should remain constant. If not repeat test 3d.
NOTE: Allow 71 to warm up for a minimum of 3 hours before completing final Calibration.

b. Final C Calibration
Zero 71 as in step 3 H.repeat Calibration of Capacitance ranges as in steps 4 a, b, c, and d.

c. Final L Calibration
Repeat Calibration of Inductance ranges as in steps 4 f, and g.

d. Linearity
Check linearity on the 100 pF range with 10 pF/step decade box, linearity must be within 1 count on DVM.

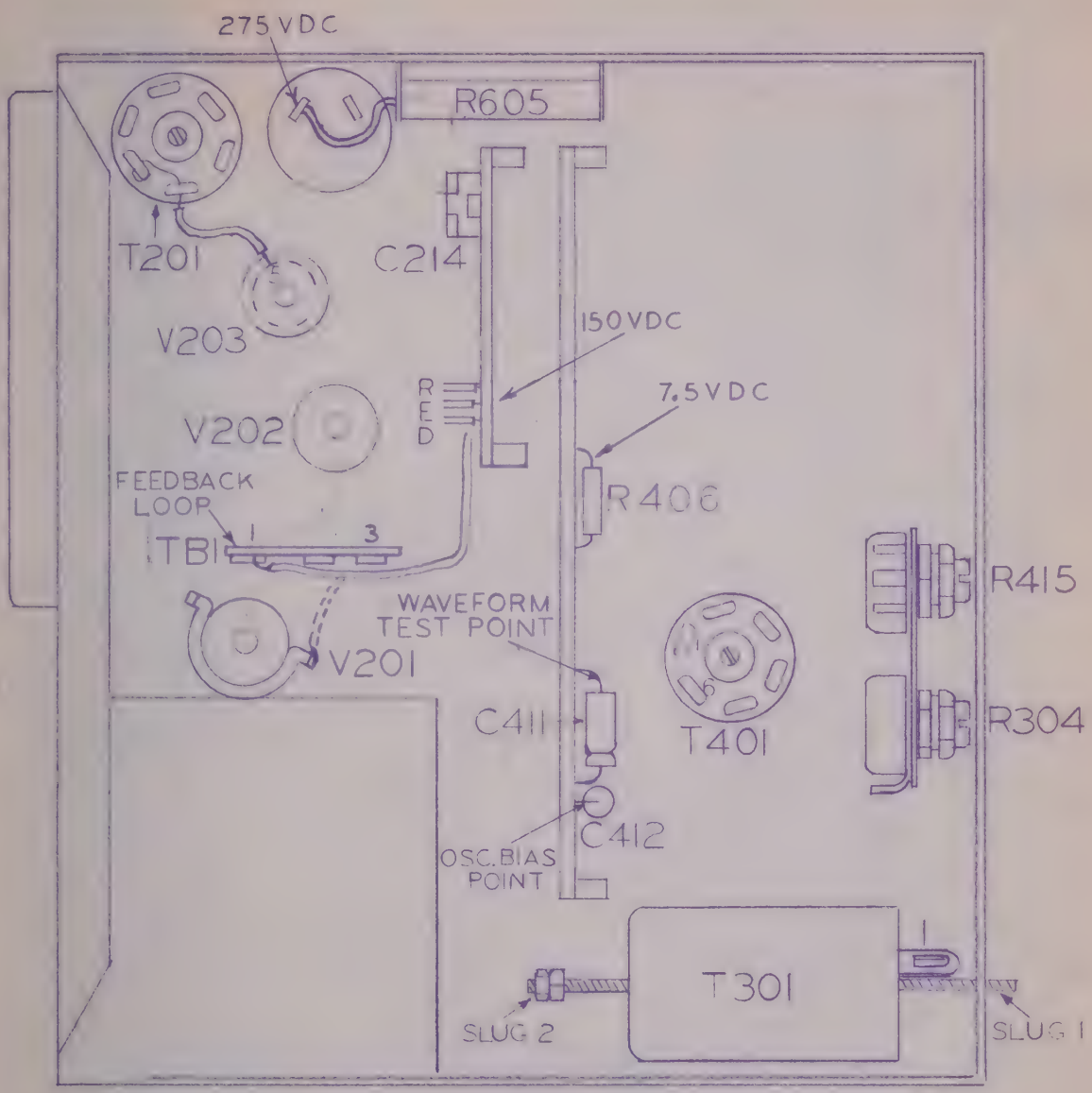

FIGURE 1

ENGR:		TEST PROCEDURE	BOONTON ELECTRONICS CORPORATION PARSIPPANY, NEW JERSEY
ENGR MGR:			
DIR. OF ENGR:		FINAL TEST PROCEDURE C-L METER MODEL 71A	
TYPIST:			TP 834,003
		PG 7 OF 9	C

ECN 5331

BEC FORM 394A

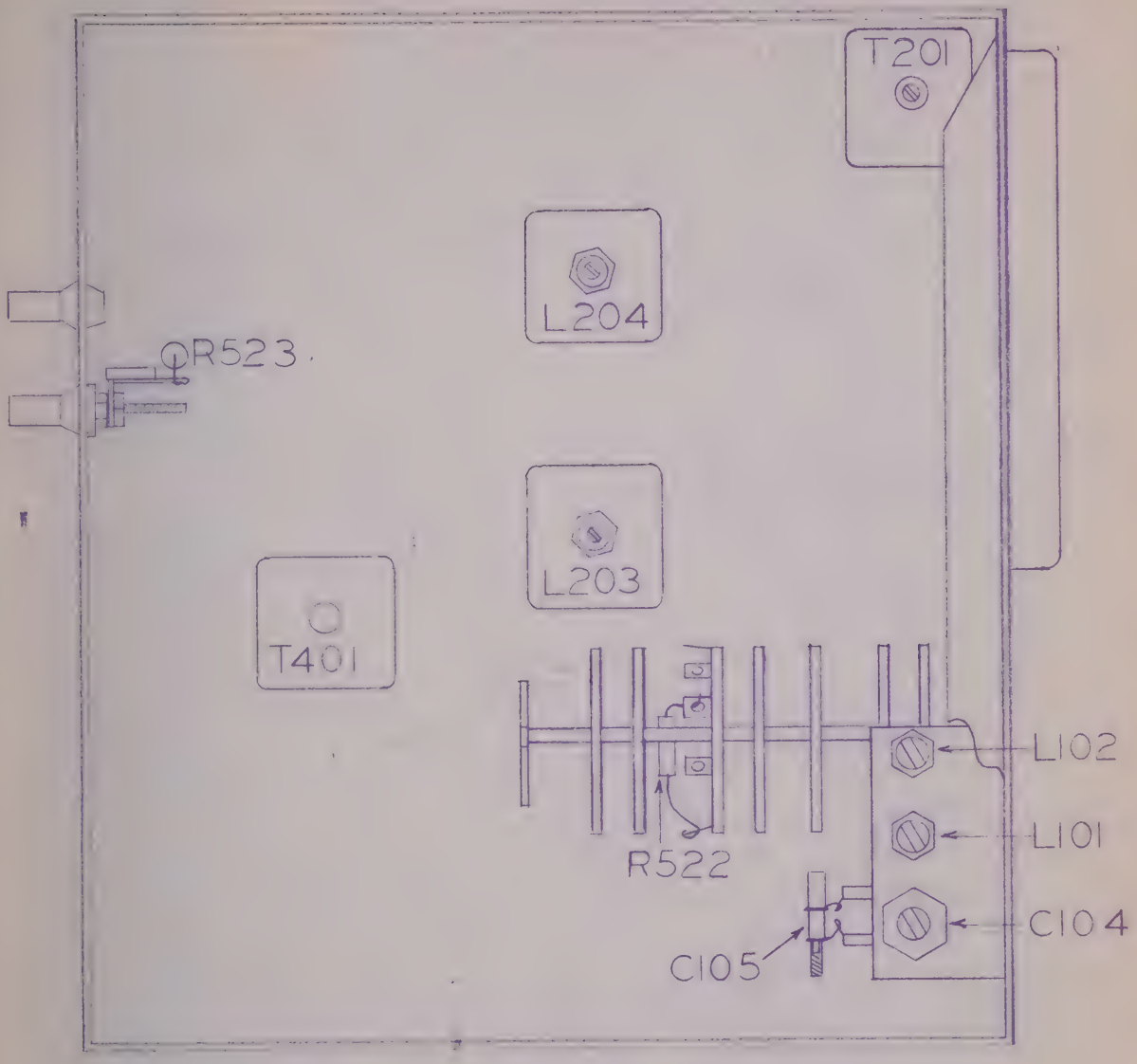

FIGURE 2

ENGR:		TEST PROCEDURE	BOONTON ELECTRONICS CORPORATION PARSIPPANY, NEW JERSEY
ENGR MGR:			
DIR. OF ENGR:		FINAL TEST PROCEDURE C-L METER MODEL 71A	
TYPIST:			TP 834,003 A
		PG 8 OF 9	

ECN 2031 A

BEC FORM 394A

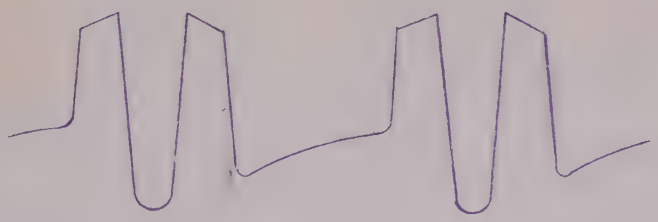

FIGURE 3

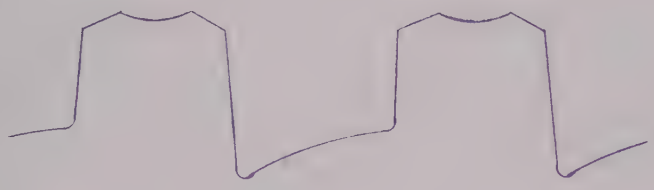

FIGURE 4

FIGURE 5

FINAL CALIBRATION RECORD

Model 71A _____
Serial # _____
Prod. Job # _____
Date _____
Inst. Book Ed. _____
Chassis # _____

1. VISUAL INSPECTION

a. Chassis	_____	f. Fuses	_____
b. Panel	_____	g. Meter Zero	_____
c. Range Knob Alignment	_____	h. DC Output Resistor	_____
d. Inductance Terminals	_____	i. Pot Lock Nuts	_____
e. Inspection Stamp	_____	j. Phase trans.Adj.Nuts	_____

2. SHOCK HAZARD

3. ELECTRICAL MEASUREMENTS

a. Unregulated dc	_____	+275 ±15V dc
b. Regulated dc	_____	+150 ±5V dc
c. Zener Voltage	_____	+7.5 ±0.4V dc
d. Oscillator Control Adj.	_____	-5.5 ±0.3V dc
e. RF Reference Voltage	_____	12.0 Vrms Min.
f. Open Loop Gain	_____	0.60 ±.2 Vrms
g. Closed Loop Gain	_____	

4. PRELIMINARY CALIBRATION

a. Comp. Adj. _____
b. 100pF Hi Lo Q Adjustment _____
c. 1000pF Hi Lo Q Adjustment _____
d. C Range Calibration _____
e. Inductance Zero _____
f. 1000μH Hi Lo Q Adjustment _____
g. L Range Calibration _____

5. DC OUTPUT CALIBRATION

a. Selection of R522 _____ 330K Min.
b. Selection of R523 _____

6. AGING _____

7. Stability

a. Line Voltage	125 VAC	_____	
	117 VAC	_____	_____
	105 VAC		_____
	Diff.	_____ <0.1%	_____ <0.1%

ENGR:	10/6/71	TEST PROCEDURE	BOONTON ELECTRONICS CORPORATION PARSIPPANY, NEW JERSEY
ENGR. MGR:	10/21/71	71A FINAL CALIBRATION RECORD	
DIR. OF ENGR:			
TYPIST:			TP 834.002 D
		PG 1 OF 2	

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8. FINAL CALIBRATION

a. Oscillator Stability Test _____

b. Final C Calibration _____

c. Final L Calibration _____

d. Linearity _____ ±0.1%

ENGR:		TEST PROCEDURE	BOONTON ELECTRONICS CORPORATION PARSIPPANY, NEW JERSEY
ENGR MGR:		71A FINAL CALIBRATION RECORD	TP 834,002
DIR. OF ENGR:			
TYPIST:			
		PG 2 OF 2	D

D ECN 2031

REC FORM 394A

MP MASTER
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